VOLUME 34 NUMBER 10 OCTOBER, 1951

AMERICAN JOURNAL OF OPHTHALMOLOGY

THIRD SERIES FOUNDED BY EDWARD JACKSON

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AMERICAN JOURNAL OF OPHTHALMOLOGY

VOLUME 34 OCTOBER, 1951 NUMBER 10

RELIEF OF INTRACTABLE BLEPHAROSPASM*

A PRELIMINARY REPORT

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Blepharospasm is a violent squeezing together of the lids due to spasm of the orbicularis oculi. Fuchs[1] divides this clinical entity into two main types: (1) Symptomatic, and (2) essential.

Symptomatic blepharospasm is that type which is due to other affections of the eye such as corneal foreign bodies, trichiasis, and most inflammations of the conjunctiva and globe. The mechanism here is probably a reflex initiated by irritation of the terminal trigeminal fibers on the surface of the eyeball. The treatment consists in the removal of the underlying etiology.

Essential blepharospasm, on the other hand, has no connection with the eye itself. The best examples of this type are hysterical blepharospasm and the senile blepharospasm of the aged. This is always bilateral and may be clonic or tonic, usually the latter.

The mechanism is not quite clear although it is assumed that here, too, some sort of reflex arc is set up. However, what initiates the reflex is difficult to say since there is no obvious organic cause.

The treatment of essential blepharospasm is and always has been difficult and ranges from psychiatric suggestion to alcohol injection and neurectomy of the upper branches of the facial nerve.

There is a third type of blepharospasm, seldom mentioned in textbooks, which is not too rare. This might be called the organic type since it has a definite neuropathologic etiology. Most commonly it is the tonic spasm of the orbicularis found in postencephalitic parkinsonism. This is a type of intractable blepharospasm which results in complete, prolonged, and violent closure of the eyelids.

A search of the literature for the exact pathology of postencephalitics parkinsonism leads one into a conflicting mesh of ideas and opinions hard to disentangle. That the pathologic process is in the extrapyramidal motor system seems fairly well established. This includes the corpus striatum, the corpus subthalamicum, the globus pallidus, and the substantia nigra.

In Parkinson's disease the pathologic process is most often found in the corpus striatum and to a lesser extent in the globus pallidus and other basal ganglia. In parkinsonian states, on the other hand, the pathologic condition is greatest in the substantia nigra. But since both these diseases follow lethargic encephalitis and since the distinction between them is not clear cut—many authorities consider them to be the same disease[2]—a search of the literature is not clarifying.

A clear-cut explanation of the why and wherefore of the clinical symptoms is also not easily arrived at. The simplest seems to be that, since the extrapyramidal system is responsible for the inhibition and control of automatic or involuntary movement and muscle tonus, its destruction removes the inhibitions, and uncontrolled spasm of irrit-

* From the Eye Service of the Goldwater Memorial Hospital. Presented before the New York Society for Clinical Ophthalmology, January 8, 1951.

Fig. 1 (Fox). Preoperative appearance of the patient.

able and uncontrolled muscles results. It is also felt that there is a strong psychic element in these cases and that this helps to create some of the bizarre patterns of muscle involvement seen.

Clinically, the disease is crippling and disabling. It is a serious condition because in severe cases the patient is, to all intents and purposes, blind and cannot fend for himself. Such a case is the subject of this paper.

Report of a case

Case History. R. G., a 45-year-old white man, was referred for consultation on March 22, 1950. In 1926, he had had encephalitis which was followed by extreme lethargy and drowsiness for the next five years. In 1931, mild blepharospasm was noted. This became steadily worse. In 1942, a tremor of the left hand developed and, by 1943, there was generalized tremor. This was associated with bilateral blepharospasm (fig. 1) which became so severe that the patient was unable to get about and had to be led everywhere. The eyes would open only for an instant at infrequent intervals ranging from 15 minutes to several hours.

Ophthalmic examination, including vision tests, was impossible even though the patient was completely coöperative and was willing to submit to any procedure which offered hope of cure.

It was obvious that drastic action of some sort would have to be taken; for here was an adult who had been completely helpless for seven years to the point of requiring some one to lead him around at all times. (He entered the hospital in a wheelchair.)

Alcohol injection of the facial nerve was considered. However, this was finally rejected as being too uncertain and probably temporary in effect. Furthermore, if effective, practically all the muscles of that side of the face would be affected as shown by the distribution of the branches of the facial nerve (fig. 2).

Neurectomy, the other definitive procedure under consideration, was rejected for

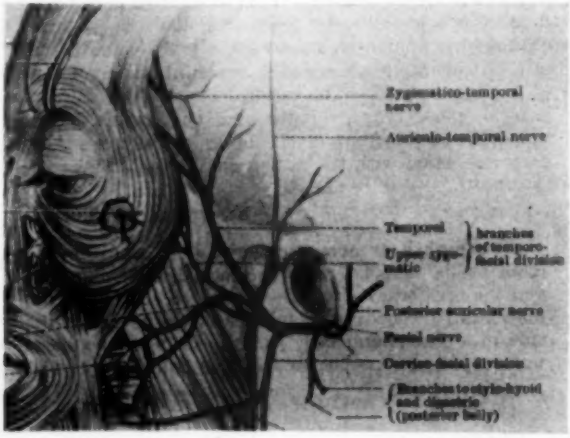

Fig. 2 (Fox). Distribution of the facial nerve. (From Cunningham's *Textbook of Anatomy.*)

Fig. 3 (Fox). Distribution of the facial nerve. (From W. Spalteholtz's *Handatlas der Anatomie des Menches.*)

similar reasons. While the effect could be limited and controlled with greater accuracy, a study of the distribution of the upper rami of the facial nerve shows that not only the orbicularis but most probably the corrugator supercilii and the frontalis would have to be involved (figs. 2 and 3).

Furthermore, considering the vagaries of the facial nerve connections—no two of the books consulted showed the same distribution (figs. 2 and 3)—paralysis of other muscles of expression was not impossible.

On top of all this was the certainty of creating a permanent and complete lagophthalmos, a prospect not to be approached lightly. As a matter of fact, at one time the idea of doing this and then recessing the levator to counteract the lagophthalmos was considered. However, this would have meant a number of procedures with the final result still in doubt. After a good deal of thought it was decided to resect the orbicularis on one side to note the effect.

A search of the literature was quite unproductive, and it must be confessed that an operation such as this, without adequate precedent, is not undertaken without some qualms, for the risk of creating lagophthalmos was present here also.

As a sort of preliminary measure and to give the patient a sample of what was intended, a block of the facial nerve by the O'Brien method was performed on May 7, 1950. This lasted for about 40 minutes. It was interesting to note that, while only the left facial nerve was injected, there was a tendency for the blepharospasm of the right side also to relax—doubtless a manifestation of the deep-seated binocularity of human vision. However, this relaxation was neither firm nor permanent (fig. 4).

It was also noted that, while the akinesia lasted, the impulse to orbicular spasm persisted and occasionally the eyes would roll up as they do normally in a position of closure. At any rate, this was the first time in seven years that the patient had been able to keep the eyes open more than a

Fig. 4 (Fox). Tendency of bilateral relaxation of blepharospasm after akinesia of left facial nerve.

Fig. 5 (Fox). The orbicularis muscle. (From J. Sobotta's *Atlas der deskriptiven Anatomie des Menchen.*)

Fig. 6 (Fox). Cross-hatched area shows extent of orbicularis resected from upper lid. (Original drawing from J. Sobotta's *Atlas der deskriptiven Anatomie des Menchen.*)

moment at a time. He was delighted. As the akinesia subsided permanent bilateral blepharospasm returned.

It was then decided that more definitive surgical treatment would be tried. To this the patient eagerly consented.

Operative procedure. On July 7, 1950, under general anesthesia the following operation was performed:

A horizontal incision following the curve of the right upper lid margin was made half way between the brow and the lid margin. This extended 10 mm. beyond the orbital rim laterally and to the nasal angle medially. The skin was dissected down to the upper border of the tarsus and upward to the hair follicles of the eyebrow. Medially and laterally full exposure of the orbicularis was attained.

A curving horizontal incision was made in the orbicularis along the upper border of the tarsus. This was carried medially to the nose and laterally the full length of the raphé. A similar horizontal incision was made through the orbicularis just beneath the eyebrow. The whole orbicularis between these incisions was resected.

Figure 5 shows the full extent of the orbicularis. The cross-hatched area in Figure 6 shows the amount of muscle resected from the upper lid.

Bleeding was stopped by pressure and the skin closed with 5-0, interrupted, black silk sutures. A monocular dressing was applied.

After complete subsidence of the postoperative edema, it was noted that involuntary closure of both lids still occurred sporadically but there were also, for the first time, prolonged periods when the operated eye stayed open (fig. 7) and sometimes both eyes.

Here again was a manifestation of the bilateral effect of weakening the orbicularis of one side only, noted previously with monocular akinesia. However, here, as previously, the binocular effect was weak and impermanent.

On July 28, 1950, an orbicularis resection of the left upper lid was similarly performed. The result was striking (fig. 8). Both eyes remained open for continually longer periods and closure became relatively less and less frequent. Normal closure of the eyes was attained without the slightest difficulty (fig. 9).

It was now possible to refract the patient. Vision was found to be 20/400 in each eye, correctible to 20/30 in each eye with a -4.5D.sph $\bigcirc$ -1.75D. cyl. ax. 180° in the right eye, and -3.0D. sph. $\bigcirc$ -1.5D. cyl. ax 180° in the left eye. The patient was able to care for himself for the first time in seven years and now travels about unaided and unaccompanied.

Discussion

This procedure, of course, does nothing to minimize or modify the nervous pathologic condition responsible for the blepharospasm. Only the effector mechanism, the muscle, has been weakened. Therein lies its fault and its virtue.

The fault is that the uninhibited stimulus to closing the lids still exists and functions. The virtue of the procedure is that it does not destroy the ability to close the lids when desired, as a neurectomy would do. Hence permanent lagophthalmos with all its attendant evils is not present.

Furthermore, the orbicularis has been so weakened that when spasm does occur it can only be short in duration and weak in efficacy. In this case it has been reduced to the point where a formerly helpless man now can and does shift for himself.

What does seem miraculous, at least to me, is that so much of the orbicularis can be resected and the lids still retain their power of closure. The anatomy of the orbicularis need not be reviewed for ophthalmologists. But it is of interest to note here that Wolff[3] assigns to the palpebral portion of the orbicularis the function of "normal" closure of the lid as in sleeping and blinking, while "the orbital portion is used to close the eye tightly."

It can now be stated that the pretarsal fibers of the orbicularis plus the few fibers remaining under the eyebrow can do all the closing and squeezing of the lids ordinarily necessary—and unnecessary.

It is possible that over a period of seven years continuous blepharospasm will cause a muscle hypertrophy of such extent that the action of such an orbicularis cannot be gauged by ordinary standards. If so, it was not of sufficient degree to attract attention at operation. (Since general anesthesia was used it was not distorted by local infiltration.) But even allowing for this possibility the ability of the few remaining fibers to maintain normal lid function and even go into spasm is, I think, remarkable.

Fig. 7 (Fox). Result of resection of the right orbicularis muscle.

Fig. 8 (Fox). Result of bilateral resection of orbicularis muscle.

Fig. 9 (Fox). Ability to close eyes is unimpaired after bilateral orbicularis resection.

Another interesting aspect of this case is the further light it throws on human binocularity. The synchronous action of the eyes in vision and movement requires no discussion. The tendency of the eyes to open and close as a team is also generally accepted as a fact although not much is made of this in the literature. Ophthalmologists know that it is not easy to keep only one eye permanently closed and that to assure immobility after operative procedure both eyes have to be patched.

It would seem that this tendency also applies to binocular blepharospasm. It is easy to understand why both eyes should tend to close occasionally after one orbic-

ularis was resected since the impulse to closure was unaffected. However, the tendency of both eyes to stay open after unilateral blocking of one facial nerve or the resection of one orbicularis is not so easy to explain. One can only postulate that human binocularity is strong enough at times to overcome even a powerful nervous blepharospasm which tends to disrupt it.

The possibility of a psychic element in these cases is important. Just how important is anyone's guess. The result attained here might be explained as a psychic reaction to operative procedure. That is always possible. However, if so, it would seem that some prolonged if not permanent improvement would have been noted after the O'Brien akinesia. None appeared.

If the cure were purely psychic, one might have expected it to be immediate and total after surgery. And if relapses were to occur, they should have begun to show gradually and increase as time went on. Progress in this case was exactly the reverse.

Immediately after operation, while the lids were still heavy and edematous, spasm occurred rather frequently but was not prolonged. As the edema cleared up the intervals of spasm became not only shorter but less frequent. At this writing four and one-half months after operation, spasm still occurs especially under stimulus of excitement as when pictures are taken. But these spasms are short, lasting no more than three or four minutes at a time at their longest.

When relaxed, the patient can go for a whole day with his eyes wide open. This is to be compared with a state of practically unbroken blepharospasm for the past seven years.

The short duration of the spasms is believed due to the fact that the muscle has been so weakened that spasm cannot be maintained now for longer periods of time. The absence of at least seven-eighths of the orbicularis from the upper lid is not psychic.

From the result obtained here is would seem that, if some of the pretarsal fibers were also resected and the orbicularis thus weakened still further, the result might be further enhanced. It is hoped that others will have the opportunity to try this procedure in the future.

This procedure should be of benefit in all types of intractable blepharospasm—no no matter what the etiology. There is so little cosmetic and functional damage to the lid that it apparently may be tried with impunity. The permanency of the result is a matter of great interest and unpredictable at this time. It is hoped to report on this at a later date.

Summary

1. Postencephalitic intractable blepharospasm, continuous for seven years, was relieved by bilateral resection of the orbicularis.

2. All of the orbicularis muscle of the upper lid except the pretarsal fibers was excised.

3. The cosmetic and functional condition of the lids is unimpaired. Ability to close the eyes is unaffected.

4. Spasm is still present but infrequent and of short duration.

5. The result is believed due to reduction of orbicularis power by resection to such an extent that prolonged spasm cannot be maintained.

11 East 90th Street (28).

I am indebted to Dr. Royal M. Howard and Dr. Paul H. Stillman for their invaluable assistance with the photography in this case.

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NEOMYCIN*

Ocular-tissue tolerance and penetration when locally applied in the rabbit eye

Adolph W. Vogel, M.D., Irving H. Leopold, M.D., and Anna Nichols, M.A.
Philadelphia, Pennsylvania

Neomycin is an antibiotic derived from Streptomyces fradiae. Preliminary studies by Waksman and co-workers[1] have shown that this agent has a wide range of antibacterial activity against both gram-positive and gram-negative organisms in vitro, as well as a significant effect on experimental and clinical tuberculosis.

However, when systemically administered, neomycin appears to have a nephrotoxic effect[2] and may produce deafness. This may limit its usefulness for infections that require systemic administration. It may be that later preparations will prove to be less toxic to the renal and aural structures.

It seemed that such a promising antibiotic agent might be useful in ophthalmology for local use. Even though local sensitivity might develop, this would not deprive the patient of another potential life-saving drug at a later date.

Studies were undertaken to determine ocular-tissue tolerance for neomycin and also its ability to penetrate into the anterior chamber when instilled into the cul-de-sac.

The neomycin used in this study had a potency of 125 units per milligram of dry weight. It was supplied by Merck and Company.

Toxicity of neomycin in the rabbit eye

Powder on cornea. Two milligrams of the dry powder were placed on six unanesthetized rabbit eyes. Immediate pain resulted, as evidenced by blepharospasm and lacrimation lasting about five minutes. Corneal areas of contact with the powder stained with fluorescein. No inflammation or irritation was noted 24 hours later, and the staining areas disappeared in two days. No opacities or scarring resulted from the pure powder being placed on the cornea.

Effect on epithelial regeneration

Standard abrasions, as previously described,[3] were made on 12 rabbit eyes. Six eyes were treated with two drops of a neomycin solution containing 5,000 u/cc. (or 40 mg./cc.) of solution in distilled water, every two hours, five times a day for five days. Petrolatum ointment containing the same concentration of the drug was applied once at night. Six eyes received no treatment.

No pain or redness resulted from the use of this concentration. By the fifth day the abrasions had lost their identity equally in both treated and control eyes, and by the sixth day the only staining noted was the punctate scattered epithelial staining found in the normal rabbit eye. The eyes were examined every other day by the slitlamp. There was no residual inflammation, scarring, or vascularization from this concentration of neomycin.

Anterior-chamber tolerance

Solutions of neomycin varying in strength from 300 u/cc. to 12,500 u/cc. (2.5 mg./cc. to 100 mg./cc.), were injected into the anterior chambers of 22 rabbit eyes. An average of 0.15 cc. was injected, and apparently this entire amount remained in the chamber, as little aqueous was noted coming out of the needle track after the needle was withdrawn.

Those eyes receiving concentrations of 2.5 mg./cc. showed only the expected aqueous beam and small strands of fibrin from the trauma of injection, within the first six hours. Higher concentrations of neomycin

* From the research laboratories of the Wills Eye Hospital and the Harrison Department of Surgical Research, University of Pennsylvania.

caused miosis, pain, dilatation of iris capillaries, clouding of the aqueous, and precipitates on the cornea and lens. Latent massive corneal edema suggested that endothelial damage had occurred in about one half the eyes injected.

In general, reactions were more marked from the concentrations of 20 mg./cc. to 100 mg./cc., and the albino rabbits evidenced a more intense response to the same concentration of drug than did the pigmented rabbits (table 1).

Tolerance to subconjunctival injections

Two tenths of a cc. of a 100 mg./cc. solution of neomycin were injected subconjunctivally in the region of the superior rectus in two rabbit eyes. There was pain after injection, manifested by blepharospasm lasting five minutes. The bleb completely absorbed in 24 hours, and in 48 hours only a few subconjunctival hemorrhages were present at the site. No inflammation or edema of the adjoining conjunctiva was noted.

Tolerance to intravitreal injections

Neomycin solutions ranging in concentration from 2.5 mg./cc. to 100 mg./cc. were injected into the vitreous chamber of 26 rabbit eyes. Fifteen received 2.5-mg. and 5.0-mg. solutions and were followed for at least a week.

No cataract formation or fundal lesions were noted in those receiving 2.5 mg. Minimal retinal lesions were seen in three eyes out of nine receiving 5.0 mg./cc. Eyes receiving 10-mg./cc. solutions or greater all manifested such damage as posterior shell cataract and/or retinal necrosis. Posterior cataract formation was almost immediate and, with the 100 mg./cc. solution, a complete cataract formed in three days.

The retinal necrosis did not appear for one to two days, and first appeared as a whitish curdlike homogenous rumpling of the medullated substance of the nerve fibers. This spread to the unmedullated position of the retina and in some cases there was complete degeneration of the entire retina. Occasionally there was a detachment of the altered

TABLE 1

Tolerance of the anterior chamber to various concentrations of neomycin

Concentration Neomycin in mg./cc.	No. Eyes	Reaction	
		1st Six Hours	Latent
100	1 B*	Miosis, pain, capillary dilatation, cloudy aqueous	Corneal edema in 24 hours. Clear in 3 weeks
60	1 W†	Cloudy aqueous, capillary dilatation, lens and corneal precipitates	Corneal edema
40	2 B	Miosis, lens and corneal precipitates	Corneal edema
20	2 B	Beam	Clear in 24 hours
	1 W	Beam, fibrin	Corneal edema
10	1 B	Beam	Clear
	2 W	Fibrin	Corneal edema, massive after 24 hours
5	2 B	Beam	Clear
	2 B	Fibrin in aqueous	Clear in 72 hours
	1 W	Fibrin, corneal and lens precipitates	Clear in 5 days (lens precipitates remain)
	1 W	Fibrin, corneal and lens precipitates	Clear in 3 days
2.5	4 W	Small amount of fibrin and beam	Clear in 2 days
	2 B	Faint beam	Clear

* B = pigmented.
† W = albino.

TABLE 2

TOLERANCE OF RABBIT EYE TO INTRAVITREAL INJECTIONS OF SOLUTIONS OF NEOMYCIN

Concentration Neomycin in mg./cc.	No. Eyes	Reaction	
		Immediate	Latent
100	2 B	Post. shell cataract in five minutes	Gradual increase in opacity through lens in 72 hours. Post. synechias in six days
60	1 B	Complete post. shell cataract	Posterior synechias, retina not visualized
40	1 B	Post. shell cataract	Retinal necrosis in three days
	1 B	Post. shell cataracts with clear peripheral zone	Retinal necrosis in three days
20	1 B		Necrosis of retina with posterior shell cataract in one day
	1 B		Necrosis of retina with large detachment of vessels
	1 B		Small area of retinal necrosis after four days; detachment of vessels into vitreous
10	2 W		Small area retinal necrosis after four days. Retinal necrosis with vessels into vitreous by two days
5	3 B		Small area retinal necrosis within three days
3	1 B		Small vitreous opacity at site of puncture
	1 B		Small area of detached vessels into vitreous
	6		Normal
2.5	5 W		Normal

medullated portion of the nerve fibers, together with the main vessels, into the vitreous.

In all cases of retinal necrosis, there was at first engorgement of the retinal vessels in the vicinity of the injection with accentuation of the terminal vessel loops, which in the normal eye are not visible or are difficult to see. The later detachment of the individual vessels into the vitreous was often surrounded by a gossamerlike envelope. These vessels were tortuous, darker and wider than normal, and appeared to extend gradually further anterior into the vitreous.

In the cases listed in Table 2, the neomycin solution was injected into the vitreous at random and this was thought to account for the variation in response—that is, in some, posterior shell cataracts formed immediately and, in others, there was necrosis of the retina without any damage to the lens.

A second series (table 3) was done in which solutions of neomycin in varying strengths were injected under direct visualization into the vitreous chamber, so that the placing of the solutions could be controlled. At the time this was undertaken, it was erroneously thought that the vessels seen extending into the vitreous were neovascularization, and an attempt was made to place small amounts of solution in close proximity to the vessels of the retina.

Procedure. The pupils were dilated by atropine ointment placed in the conjunctival cul-de-sac the night before. The animals were anesthetized with nembutal (60 mg. per five pounds of body weight). Each animal was laid on its side with the operated eye up and luxated. The eye was held in the luxated position with an eye speculum.

The site of entrance of the needle was at the juncture of the anterior edge of the superior rectus and a fold of conjunctiva which always appeared when the eye was luxated.

TABLE 3

CHANGES IN INTRAOCULAR STRUCTURES AFTER LOCALIZED INTRAVITREAL INJECTIONS OF NEOMYCIN

Concentrations Neomycin in mg./cc.	No. Eyes	Depth	Result
40	3 W	Over nervehead	Vas. seg.; pet. hem., dilatation and segment. Smaller vessels, necrosis retina, detach. into vitreous, exudate
	1 B	Into center of vitreous with eye facing up	Post. shell cataracts, retinal necrosis
	1 B	Into center of vitreous with eye facing down	Post. shell cataract, retinal necrosis
	1 B	Over main vessels 1 disc diam. anterior to nervehead	Vas. seg. main vessels, retinal necrosis
20	5	Over retina near nervehead	Vas. seg. detached tortuous main vessels extending into vitreous
	1 B	Center	Post. shell cat., segmentation of vessels, retinal necrosis
2.5	9 W	Over main vessels, 1 disc diam. anterior to nervehead	No change noted

A vortex vein is usually present at this site, but only one choroidal hemorrhage was noted in 35 punctures.

A guard was fashioned out of No. 0.007 piano wire and was wound on the needle so that it could be safely and accurately guided to the desired depth. This controlled placing of experimental lesions of the retina by direct observation is similar to that used by Brower and others.[4]

By using the guard and the ophthalmoscope it was found that a good degree of accuracy could be obtained in placing the tip of the needle in very close proximity to the surface of the retina without actually touching it. If the needle was allowed to rest lightly on the medullated fibers, a definite crease was formed which could also be used as a marker.

The landmark just noted—of superior rectus, fold of conjunctiva, and vortex vein—was a constant one and, in several trial eyes, three punctures were within, at most, two mm. of each other.

Twenty-one rabbit eyes were injected with solutions of neomycin varying in strength from 2.5 mg./cc. to 40 mg./cc., intravitreously, and at controlled depths and positions in the vitreous chamber. The depths selected were at the retinal surface, over main vessels, over the nervehead, and into the center of the vitreous.

Results. Those receiving 2.5 mg. did not show any damage. Those in the 20-mg. and 40-mg. group all showed damage depending on the site of contact.

Material injected into the center of the vitreous caused both posterior shell cataract and retinal damage. Material containing 20 mg./cc. or greater could be seen leaving the needle tip, as it is of a yellowish color and apparently of different density than the vitreous humor. Material placed centrally in the vitreous rose to the posterior lens surface and caused immediate haziness, followed by the posterior shell cataract in 24 hours.

In one animal, the operated eye was placed down to see if the material would then rise to the retinal surface from the center of the vitreous, and thus leave the lens surface untouched. After a 15-minute interval with the eye in the "down" position, it was seen that the lens surface had been touched in spite of the position, with beginning formation of the posterior shell cataract. In this animal the retina was also involved showing that the material had diffused in both directions.

In general, the involvement of the retinal structures is as follows: Within a half hour after injection of a solution of 20 mg./cc. as close to the retinal surface as possible without traumatizing it, there is an apparent slowing of the blood column in the second and third division of the arterioles and venules, in the immediate vicinity. There is definite segmentizing of the blood column. The vessels show definite local constriction and the blood moves only slightly and irregularly in some of the affected vessels.

Then within 24 to 48 hours there is detachment of the involved vessels from the retinal surface. In this vicinity a characteristic curdlike white rumpled membrane appears with some fragmentation and curling up of debris. This necrosis often spread beyond the vascularized retina, but in most eyes seemed to start in it. The main vessels were also later affected, showing segmentizing of the column, petechial hemorrhages, and exudates in their course. The sequence of alterations depends on the site of contact with the antibiotic.

Thus in high concentrations neomycin appears to cause closure of the retinal vessels. This may be due to extreme vasoconstriction or possibly to local sludging in the blood column.

Penetration through the intact and abraded cornea into anterior chamber

Normal adult albino rabbits were used. One drop of 0.5-percent pontocaine solution was dropped into the conjunctival cul-de-sac prior to tapping the anterior chamber with a No. 26 needle and after the cul-de-sac had been thoroughly flushed with normal saline.

Neomycin solution, 5,000 units/cc. (40 mg./cc.) aqueous, was dropped on the cornea once every five minutes for six times and the anterior chamber tapped at varying intervals after the last drop.

The cup-plate method was used in the determination of the presence of neomycin in the aqueous samples. Owing to the inaccuracy of the method used, only the presence or absence of neomycin could be determined. Accurate evaluation was not possible by this method. Plates were seeded with Bacillus subtilis and Staphylococcus aureus, the samples being divided equally between the two organisms. No significant difference was seen in the effect of neomycin on the two organisms. It is evident from the data listed in Table 4 that locally instilled neomycin penetrates into the anterior chamber and that increased penetration occurs where the epithelial barrier has been removed.

TABLE 4

Penetration of neomycin solution (drops) into anterior chamber of normal rabbit eyes

Samples	Time after Last Drop	Presence Neomycin
Intact Cornea	(minutes)	
4	15	+
4	30	+
2	60	+
2	120	+
Abraded Cornea		
2	15	++
2	60	++

Neomycin solution, 2,500 u/cc. (20 mg./cc.) aqueous, was dropped on the cornea once every five minutes for six times and the anterior chamber was tapped at varying intervals after the last drop.

Discussion

These data show that solutions of neomycin containing 40 mg./cc. (5,000 units/cc.) can be safely applied to the normal abraded rabbit cornea without producing any harmful effect. This concentration has been tried on human eyes without any undesirable results, except for slight subjective irritation. This concentration will penetrate through the cornea into the anterior segment when locally instilled. Even the pure powder causes no permanent objective changes, although it is quite uncomfortable.

Concentrations of 2.5 mg./cc. (approximately 300 units/cc.) can be injected into the anterior chamber without producing any permanent tissue change. Higher concentra-

tions produced considerable corneal edema, suggesting damage to the corneal endothelium. The only lens changes consisted of deposits of fibrinous material on the anterior lens capsule.

The same concentration (2.5 mg./cc.) can be used for intravitreal injections. Stronger concentrations, however, damage the lens and retina. The retinal effect is chiefly a vascular one.

It is interesting to note that concentrations that produced cataracts when placed in the posterior segment do not produce similar lens changes when placed in the anterior chamber. This could mean that the posterior capsule is more vulnerable than the anterior. It is also possible that the movement of fluid in a posterior to anterior direction protects the anterior capsule. Such a flow would not help the posterior capsule.

Summary

1. Neomycin in concentrations up to 40 mg./cc. (5,000 units/cc.) may be safely employed for drop instillation into the eye.

2. Neomycin in concentrations up to 40 mg./cc. (5,000 units/cc.) does not interfere with epithelial regeneration of the rabbit cornea.

3. Neomycin solution, 40 mg./cc., will penetrate into the anterior chamber of the normal rabbit eye when instilled as drops. Penetration is increased in the presence of abraded corneas.

4. Neomycin solution, 2.5 mg./cc., may be safely injected into the anterior and vitreous chambers of rabbit eyes. Higher concentrations may result in damage to the corneal endothelium, permeability of vascular structures of the anterior segment, lens, and retinal vascular system.

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COMPARISON OF ORTHO-RATER AND SIGHT-SCREENER TESTS OF HETEROPHORIA WITH STANDARD CLINICAL TESTS*

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INTRODUCTION

This study is part of a general investigation of the reliability and validity of measures of visual functions provided by instruments such as the ortho-rater and the sight-screener. One phase of the general investigation is concerned with the evaluation of such devices for use in selection tests to determine fitness for particular occupations, for example, in industry or in the military services. The present study is devoted to this phase of the problem, and seeks to determine how closely the ortho-rater and sight-screener agree with standard clinical tests of heterophoria, in particular with reference to their use as selection tests. No attempt is made to check the validity of selection standards.

Since in our studies modifications were made in the instruments, the conclusions reached are not necessarily applicable to the results of tests in which the standard instruments and procedures are used.

The one fundamental and essential difference between instruments such as the ortho-rater and the sight-screener and the commonly used clinical tests is that, in the former, the optical distance of the test targets may be less than their actual distance. In all such instruments, the targets used to test distance phoria are actually only 13 or 14 inches from the eyes, and the desired relaxation of accommodation is produced by means of plus lenses before the eyes.

In the sight-screener, the near targets are viewed at their actual distance, without the interposition of any lenses before the eyes. In the ortho-rater the actual distance of the near, as well as the distance, targets is less than their optical distance.

The unique space-saving feature of the machine tests introduces a possible source of error which requires that they be evaluated by comparison with the better clinical tests to insure that simulation of distance by optical methods does not introduce a significant error in the measures of lateral phoria. Some of the commonly used clinical tests may also require investigation to determine the adequacy with which they themselves measure phorias.

Such factors as the maintenance of accommodation of the eyes for the testing distance might be examined. For example, when the Maddox-rod test is given in a dark-room, the subject sees only a spot and a streak of light, neither of which have sharp borders. Accommodation of the eyes for the testing distance may, therefore, not be maintained as accurately as in tests in which the targets fixated provide sharp outlines for the accurate control of accommodation.

Even when adequate measures of phoria are employed, the adoption of qualifying standards to determine fitness for particular jobs presents a difficult problem, because a moderate amount of heterophoria may, in one individual, interfere markedly with comfortable and efficient use of the eyes and, in another individual, be tolerated without any discomfort or impairment of efficiency.

Since, therefore, any qualifying standards of phoria must of necessity be somewhat arbitrary, a selection test to be acceptable need show only moderate reproducibility and mod-

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TABLE 1

TEST-RETEST CORRELATIONS

Investigator	Imus	Sulzman, Cook & Bartlett
Far Lateral		
Clinical test	0.81	0.79
Ortho-rater	0.87	0.87
Sight-screener	—	0.80
Near Lateral		
Clinical test	0.90	0.87
Ortho-rater	0.81	0.92
Sight-screener	—	0.83
Far Vertical		
Clinical test	0.64	0.62
Ortho-rater	0.79	0.63
Sight-screener	—	0.61
Near Vertical		
Clinical test	0.74	0.68
Ortho-rater	0.73	0.62
Sight-screener	—	0.55

erately high correlation with other tests based on established principles. Evaluation of the merits of the machine tests is, in this study, based chiefly on a comparison of these tests with several recognized clinical procedures. As stated earlier, the study does not include an investigation of the adequacy of qualifying standards such as have been set by the military services and by industrial organizations.

PREVIOUS INVESTIGATIONS

Studies by Imus[1] and by Sulzman, Cook, and Bartlett[2] indicate that the test-retest reliabilities of the standard ortho-rater and the sight-screener tests are of about the same magnitude as those of the Maddox-rod test. Their data on the reproducibility of the different tests are summarized in Table 1.

Previous investigators are not in agreement as to the degree of correlation between instrument and clinical tests. Their findings are given in Table 2.

The lack of agreement in these studies as to the degree of relationship between clinical and machine tests as measured by the correlation coefficient might be attributed in part to differences in range of defect in the different groups studied. Since no investigator gave more than one clinical test to the same subjects that were tested on the machines, it is not possible to determine whether different forms of clinical tests would have agreed any more closely with one another than with the machine tests.

Both Wirt[3] and Davis[4] used clinical tests

TABLE 2

INTERCORRELATIONS

	Wirt	Davis	Imus	Sulzman, Cook & Bartlett
Far Lateral				
Clinical and ortho-rater	0.76 to 0.84	0.53	0.70	0.56
Clinical and sight-screener	—	—	—	0.37
Maddox rod and screen-parallax	—	—	—	0.74
Near Lateral				
Clinical and ortho-rater	—	0.64	0.77	0.67
Clinical and sight-screener	—	—	—	0.54
Maddox rod and screen-parallax	—	—	—	0.70
Far Vertical				
Clinical and ortho-rater	—	—*	0.49	0.29
Clinical and sight-screener	—	—	—	0.28
Near Vertical				
Clinical and ortho-rater	—	—*	0.50	0.34
Clinical and sight-screener	—	—	—	0.34

* No correlation was computed because a majority of the subjects showed vertical orthophoria.

which provided details for control of accommodation. In the other two studies[2,5] the Maddox-rod test was used. It is perhaps of significance that Wirt, who obtained the highest correlations for lateral phoria at distance, used a clinical test very similar to that of the ortho-rater in which the test targets are an arrow and a numbered scale, and phoria is measured directly by the location of the arrow in relation to the scale. This type of test is in common use among ophthalmologists for testing near phorias, but is seldom used at distance, probably because of the great amount of space required for the scale.

It is possible that lack of agreement between clinical and machine tests depends more on differences in the test targets than on the factors related to the optical simulation of distance in the machine tests. It is apparent, therefore, that further investigations are needed to determine whether there are essential and significant differences between instrument and clinical tests of phoria.

Present investigation

In this study, three different tests of the clinical type with targets at true rather than at optically simulated distances were compared with each other and with modified forms of the ortho-rater and sight-screener tests. The experimental conditions were chosen so as to eliminate as far as possible any differences not essential to the particular type of test. This will be clear from the description of the tests which follows.

Description of tests

A. *Maddox-rod and scale.** As used in this study the test employs linear scales consisting of a series of lines separated by one prism diopter (six cm. at six meters). The vertical scale has, in addition, dots marking the 0.5 prism-diopter intervals. An illuminated spot is located at the zero point of both scales.

A white Maddox rod is placed in front of the left eye, which sees therefore only a streak of light, whereas the right eye sees the scale and the spot of light at its center. A white rod was chosen rather than a red one because the eye is more hyperopic for red than for white light. The spurious hyperopia produced in the eye which views a red streak of light may induce a greater amount of accommodation than is required under normal conditions of seeing.

The subject reports at what point the streak of light intersects the calibrated scale. The scale for phoria at distance is located six meters from the subject, with its center approximately at eye height. The diameter of the spot is one cm. A similar reduced scale for the near tests is located 39 cm. from the cornea (approximately 40 cm. from the center of rotation of the eyes), and about 20 degrees below the primary position.

Two types of measurement were made with the rod and scale device—"binocular" and "cover." In the binocular test, a single estimate was recorded of the location of the streak after it had come to rest, or of its average location if it continued to fluctuate. In the cover test, four separate determinations were made of the location of the streak immediately after an occluder was removed from the right eye. The eye was uncovered for a period of about one second at about two-second intervals.

The screening procedure was included because it provides a simple and convenient means of making repeated determinations. All tests were made with a screening of the right eye. If the left eye had been screened, when it was uncovered a shift in fixation of the right eye would usually have been necessary in order to judge the location of the streak on the scale.†

* This is sometimes known as the Maddox cross.

† According to Cridland,[6] any test of phoria may be falsified if the images of the right and left eyes do not fall on the two foveas, because a fixation reflex is called into play. If an image is presented to an eye already in the "fusion-free" position, it must not incite any movement of the eye away from that position.

B. *Maddox rod and phorometer.* As used in this study, this test employed the same equipment as the previous one and differed from it only in that the separation between spot and streak was measured in terms of the strength of prism necessary to make the streak pass through the spot. For uniformity with the previous test, the Maddox rod was placed over the left eye. A Risley rotary prism before the right eye was used for measurements of lateral phoria, a Stevens phorometer prism for measurements of vertical phoria. (Lateral phoria was measured to the nearest prism diopter, vertical phoria to the nearest 0.2 prism diopter.) The subject himself adjusted the variable prism. Four separate adjustments were made, two from each direction. The cover technique was not used in this test, since successive determinations can conveniently be made by the binocular method.

An important difference between this test and the Maddox-rod test as it is frequently given is that the well-illuminated screen, with the calibrated scales used in the previous test, was visible to the right eye and provided fine detail for the control of accommodation at both far and near. Some authorities state that accommodation should be "avoided" in testing phoria at six meters and recommend, therefore, that the test be given in a darkened room in which only the spot and streak are visible.

When the eyes are made emmetropic by correcting lenses, it is possible that the findings are relatively independent of the presence or absence of detail in the field of view.[7] When, however, the subjects tested include individuals with significant amounts of uncorrected hyperopia this cannot be true.

It is our opinion that accommodation both at far and at near should be controlled and should correspond to that normally required by the subject at each distance. In the testing of military personnel, for example, who will normally not wear glasses for the correction of minor errors of refraction, measures of the phorias without correction are of more significance than those obtained with correction.

A second difference between this test and the usual clinical procedure is the use of a white rather than a red Maddox rod for the reasons previously mentioned.

C. *Grid and polaroid test.* This test is a part of the ophthalmo-eikonometer. By means of polaroid filters, a grid calibrated in prism diopters is presented to one eye, a dot to the other. For the reasons previously given in this study, a white dot was substituted for the red one of the standard instrument. The dot was presented to the left eye, the grid to the right. The far grid was located five meters from the eyes with its center at approximately eye height. The near grid was 39 cm. from the corneas (approximately 40 cm. from the centers of rotation) and about 22 degrees below the primary position.

To conform with Tests A and B the dot was presented to the left eye, the grid to the right, and a single binocular determination, followed by four successive determinations with screening of the right eye, was made. Lateral phorias were measured to the nearest prism diopter, vertical phorias to the nearest half prism diopter. This test is perhaps less satisfactory than the two previous ones in several respects.

1. For the sake of uniformity it would have been better to make the distance tests at six rather than at five meters.

2. The distance screen on which the grid was shown was too small to fill the entire field. Vertical borders of the screen may, therefore, have introduced a fusion stimulus.

3. At both far and near, some subjects were able to see a faint image of the grid with the left eye, because of incomplete polarization. This "ghost image" was not entirely eliminated by reducing the brightness of the grid.

4. The use of the same grid to measure both horizontal and vertical phorias was confusing to some subjects who did not understand that they were to give separate reports

as to the lateral and vertical locations of the dot.

D. *Sight-screener.* This instrument also uses polaroid to present dissimilar images to the two eyes. In the test for lateral phorias, the left eye sees an arrow, the right eye a numbered scale of dots. In the vertical phoria test the left eye sees a vertical row of dots, the right eye a horizontal line. The scale for measuring lateral phoria is calibrated in units of one prism diopter, that for measuring vertical phoria in units of 0.5 prism diopter. The test slide used in this study was a specially constructed one which permitted measurements over a wider range than is provided in the standard sight-screener.

The near targets are about 40 cm. from the centers of rotation of the eyes and about 20 degrees below the primary position. The far test differs from the previously described tests in that a distance of six meters is simulated by means of prisms and lenses.

The targets viewed by each eye were carefully inspected to insure that there was no perceptible ghost image, that is, no faint image of the right-eye target visible to the left eye, or vice versa. As in previous tests, a single binocular reading was made of the location of the index on the scale after it had come to rest. This was followed by four successive determinations of its location immediately after the cover was removed from the right eye.

E. *Ortho-rater.* In the ortho-rater, prisms and lenses are used both at near and at far to obtain the desired apparent location of the right and left eye images. The optical distances are 7.6 meters and 37 cm. The distance targets are 15 degrees below the primary position, the near targets, 35 degrees below.

In the lateral phoria tests, the right eye sees a row of numbered white spots; the left eye sees three similar spots and an arrow. Because of the three spots in the left eye target, the arrow remains steady and exactly in line with one of the spots seen by the right eye. The scales are calibrated in units of one prism diopter at far, 1.5 prism diopters at near.

In the vertical phoria tests, the left eye sees a horizontal row of dots; the right eye a series of stairstep figures.

A demonstration model was used to explain this test. It consisted of a row of dots which could be moved up or down and right or left in relation to the stairstep figures. In preliminary studies made without this demonstration, some subjects misunderstood the instructions and reported the lateral rather than the vertical location of the dots relative to the stairstep figures.

In the standard test, the left eye image is composed of red dots. In this study, white dots were substituted in order to avoid producing an artificial hyperopia in the left eye. The slides used differed from those of the standard instrument also in that a wider range of lateral and vertical phorias could be measured. As in previous tests a single binocular reading was followed by four successive measurements with screening of the right eye.

Procedure

The subjects given the five different phoria tests were patients who came to the Wilmer Dispensary for an eye examination. Patients showing any evidence of ocular disease were excluded. With few exceptions, the age of the subjects fell within the limits of 12 and 40 years. Some were tested with correction of refractive error. Others who did not normally wear their glasses at all times were tested without them. It is probable that this group of subjects includes a higher proportion with significant amounts of heterophoria than would occur in the general population.

In approximately one half of the cases, the ortho-rater test was given first; in the other half, the sight-screener was the first test. The third, fourth and fifth tests were the rod and scale, rod and phorometer, grid and polaroid.

The binocular test preceded the cover test

in each case. In the occasional instances in which other visual tests were given to the same subject, the phoria tests were always completed before any tests requiring binocular fusion. Wirt has shown that a significant increase in the mean lateral phoria (in the direction of esophoria) can occur when the phoria test follows such other tests.*

The raw scores on the machine tests were converted to prism diopters by means of data provided by the manufacturers. On the ortho-rater, zero prism diopters of phoria correspond to optical orthophoria. In the case of the sight-screener an instrumental score of zero prism diopters of lateral phoria at distance corresponds optically to an esophoria of approximately 1.7 prism diopters. This value was chosen as clinically equivalent to orthophoria in order to compensate for increased convergence in the machine test induced by awareness of the actual nearness of the targets.

Some of the tests cannot measure hyperphorias greater than 2.5 prism diopters, esophorias greater than 10, exophorias greater than 10 at far, 14 at near. In comparing the results of the different tests, therefore, these limiting values were arbitrarily assigned to the higher degrees of phoria which could be measured on certain tests.

Statistical analysis of results

A. *Tests of lateral phoria at distance.* One of the criticisms of tests of lateral phoria in which distance is simulated optically is that awareness of the actual nearness of the targets may induce more convergence than would be shown if the targets were actually at a distance. The effect of such "apparatus convergence" when present is to shift the mean scores on machine tests in the direction of esophoria (that is, to increase the plus value of the scores if esophorias are considered positive, exophorias negative). In the sight-screener, an attempt has been made to allow for apparatus-convergence by making instrumental orthophoria (heterophoria of zero) correspond to an actual optical convergence of approximately 1.7 prism diopters.

Examination of the mean scores, given in Part 1 of Table 3, shows, however, no evidence of apparatus convergence in either of the machine tests. The mean scores for tests at true distance range from +0.5 to +1.4 (+0.5 to +1.4 prism diopters of esophoria). The mean ortho-rater scores of +0.93 and +0.94 fall within this range. The mean sight-screener scores are −0.9 and −1.0. Since these instrumental scores correspond to true optical scores of +0.8 and +0.7, it is apparent that no allowance need have been made for apparatus convergence.

The correlation coefficients given in Part 2 of Table 3 are indices of the degree of the association between the scores on the nine tests of heterophoria which were given to the same individuals. From this table it is apparent that, as measured by the correlation coefficient, the association between the machine tests and the clinical tests is as close as that between the clinical tests, one with another. It is interesting to note the very high values obtained when the single binocular measures are compared with the average scores based on four determinations by the cover technique.

The rod and scale, ortho-rater, and sight-screener tests each have a correlation coefficient of 0.98 and the polaroid and grid test has one of 0.94, for this comparison. It is possible that these coefficients give spuriously high estimates of the reproducibility of each test, if the subject, because of a memory factor, tends to give the same response when the cover tests are given immediately after the binocular test. In any case the high correlations indicate that not a great deal is

* This precaution was not observed in previous studies in which all subjects were given the complete standard battery of tests on the sight-screener and the ortho-rater. In the standard sight-screener, the phoria tests both at far and at near are immediately preceded by a test of depth perception. In the standard ortho-rater, the phoria tests at distance are given first; those at near are immediately preceded by tests of acuity requiring fusion.

accomplished by making repeated measures of far lateral phoria in the same test session.

The correlations of Test 2 (rod and scale cover test) with Tests 1 and 3 (phorometer and polaroid cover tests) are respectively 0.90 and 0.95. The correlations of Test 2 with Tests 4 and 5 (ortho-rater and sight-screener cover tests) are, respectively 0.94 and 0.93.

It is apparent, therefore, that the relationships between the machine tests and one of the clinical tests are as close as the relationships of the different clinical tests to one another. Single binocular measures on the machine tests likewise correlate highly with the rod and scale cover test—that is, 0.91 for the ortho-rater and 0.92 for the sight-screener.

In this study the correlations between clinical and machine tests of lateral phoria at distance are higher than those reported by Imus[1] and by Sulzman, Cook and Bartlett.[2] The higher correlations are perhaps attributable to the differences in testing conditions, such as the provisions for control of accommodation in the clinical tests, and so forth. Higher correlations would also be found if the subjects of our study included a greater number with high amounts of heterophoria.

A better basis for comparing the results of studies on different groups of subjects whose range of heterophoria may differ is provided by the statistical measure known as the standard error of estimate. This so-called standard error of estimate is simply the standard deviation of the observations from a calculated regression line and thus it indicates how much the points deviate above and below the regression line.

Figure 1, in which are graphed the scores on the ortho-rater cover and phorometer tests, illustrates the meaning of this constant. The regression line AB in Figure 1 shows the expected phorometer score for each ortho-rater score. The vertical separation between the regression line and each of the dashed lines is equal to twice the standard error of estimate. This interval, 3.3 prism

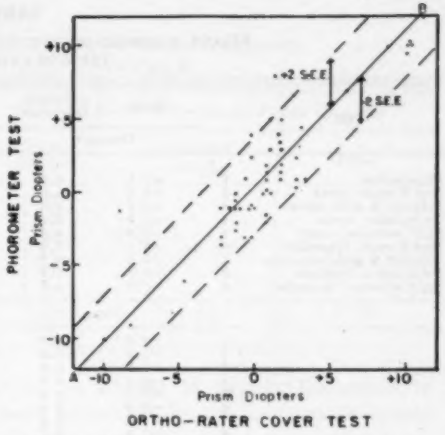

Fig. 1 (Sloan and Rowland). An illustration of the meaning of the standard error of estimate. See text for explanation.

diopters, is therefore an index of the amount by which the individual scores on the phorometer test are likely to deviate from the expected scores.

Table 4 gives some comparative values of standard errors from this and previous studies. The standard errors are, as might be expected, slightly smaller when based on an average of four measures than when based on only a single determination. The machine tests are somewhat more accurate in predicting scores on the rod and scale test than on the rod and phorometer test. The investigation by Sulzman, Cook and Bartlett[2] shows higher errors of estimate than were found under comparable conditions in this study, whereas that of Wolpaw and Imus[3] agrees closely with our findings.

Certain ranges of scores on clinical phoria tests are now accepted as indicative of normal muscle balance in the selection of military personnel for specific tasks. If tests of the machine type are substituted for the standard clinical tests, it is important to know whether the new and the old tests will agree closely as to the subjects who pass and who fail. This comparison might be made by setting up a four-fold table for each of the possible pairs of tests. When, for exam-

TABLE 3

MEANS, STANDARD DEVIATIONS, AND INTERCORRELATIONS OF TESTS OF LATERAL PHORIA

Test		Mean	Standard Deviation	Correlation Coefficients							
		Distance		Series I, 50 Cases							
				1	2	3	4	5	6	7	8
Phorometer	1	+1.4	4.5								
Rod & scale, cover	2	+0.8	3.6	0.90							
Polaroid & grid, cover	3	+0.6	3.8	0.87	0.95						
Ortho-rater, cover	4	+0.9	3.7	0.90	0.94	0.92					
Sight-screener, cover	5	−0.9	4.2	0.90	0.93	0.89	0.92				
Rod & scale, binocular	6	+1.1	3.9	0.94	*0.98*	0.95	0.92	0.92			
Polaroid & grid, binocular	7	+0.5	3.5	0.82	0.87	*0.94*	0.87	0.81	0.89		
Ortho-rater, binocular	8	+0.9	3.8	0.88	0.91	0.91	*0.98*	0.88	0.91	0.87	
Sight-screener, binocular	9	−1.0	4.0	0.89	0.92	0.86	0.92	*0.98*	0.90	0.77	0.88
		Near		Series I, 50 Cases							
	1	−2.6	6.9								
	2	−1.4	6.0	0.96							
	3	−2.5	6.0	0.88	0.93						
	4	−1.6	6.9	0.74	0.75	0.80					
	5	−2.5	6.2	0.90	0.90	0.92	0.83				
	6	−0.9	5.6	0.93	*0.93*	0.88	0.71	0.85			
	7	−1.6	5.8	0.85	0.88	*0.94*	0.74	0.87	0.92		
	8	−1.3	6.7	0.69	0.70	0.76	*0.98*	0.79	0.66	0.71	
	9	−2.2	5.9	0.85	0.82	0.86	0.76	*0.94*	0.89	0.90	0.72
		Near		Series II, 50 Cases							
	1										
	2	−3.4	4.9								
	3										
	4	−3.3	6.0		0.80						
	5	−3.5	5.1		0.81		0.81				
	6	−3.4	4.2		*0.89*		0.72	0.68			
	7										
	8	−2.7	5.8		0.75		*0.95*	0.78	0.65		
	9	−3.0	4.9		0.75		0.75	*0.93*	0.76		0.70

Note: The *italic* coefficients are the correlations between scores on the same form of test when based on a single binocular measure and on the average of four measures by the cover method.

ple, scores from −4 to +5 are taken as indicative of normal lateral muscle balance at distance, the following tables comparing the results of the rod and scale cover test with those of the phorometer and ortho-rater cover test result.

		Rod and Scale	
		Pass	Fail
Phorometer:	Pass	39	0
	Fail	2	9
Ortho-rater, cover:	Pass	41	0
	Fail	0	9

In the application of this method to the sight-screener cover test it is necessary to take as limits for passing −6 and +3 because of the shift in the zero point of the scale which was discussed previously. If this is done a similar table is formed, thus:

		Rod and Scale, Cover	
		Pass	Fail
Sight-screener, cover:	Pass	41	1
	Fail	0	8

It is apparent without the application of any significance test that the ortho-rater and sight-screener agree as well with the rod and scale test as does the phorometer test. When this type of comparison is made for all of the other pairs of tests, in each of the tables, 46 or more of the 50 subjects are classified alike by the two tests. Although space has not been taken to show all of the tables, it may be said that they confirm the conclusion suggested by the correlation coefficients, that in testing for lateral phorias the machine tests agree as closely with accepted clinical tests as these do with each other.

B. *Tests of near lateral phoria.* Part 2 of Table 3 gives for the same 50 subjects the intercorrelations for the nine tests of near lateral phoria. Again the correlations between single binocular measures and averages of four determinations by the cover technique are high, namely 0.98 for the

TABLE 4

STANDARD ERRORS OF ESTIMATE OF TESTS OF LATERAL PHORIA AT DISTANCE
(Score on Test A predicted from score on Test B)

Test A	Test B	Standard Error of Estimate, Prism Diopters		
		This Study	Sulzman, et al.	Imus
Rod & scale, cover	Ortho-rater, cover	1.27		
Rod & scale, cover	Sight-screener, cover	1.35		
Rod & scale, cover	Ortho-rater, binoc.	1.49		
Rod & scale, cover	Sight-screener, binoc.	1.41		
Phorometer	Ortho-rater, cover	2.01		
Phorometer	Sight-screener, cover	1.95		
Phorometer	Ortho-rater, binoc.	2.16	3.12	2.10
Phorometer	Sight-screener, binoc.	2.06	3.51	

ortho-rater test, 0.94 for the polaroid and sight-screener tests, and 0.93 for the rod and scale test.

The ortho-rater, though highly reproducible, shows, nevertheless, lower correlations in general with the other tests of near lateral phoria. For example, in the array of 36 coefficients in Table 3, the 12 lowest, ranging from 0.66 to 0.79, are all correlations between one of the ortho-rater tests and another test. This suggests that there is some specific source of error in the ortho-rater test of near lateral phoria. As will be shown presently, a defect was located and eliminated in later studies.

The correlations of Test 2 (rod and scale cover test) with Tests 1 and 3 (phorometer and polaroid cover test) are, respectively, 0.96 and 0.93 and that of Test 1 with Test 3 is 0.88. The correlations of Test 5 (sight-screener cover test) with Tests 1, 2 and 3 (clinical tests at true distance) are 0.90, 0.90, and 0.92. We may conclude, therefore, that when four measures by the cover method are used, the sight-screener agrees about as closely with clinical tests as these do with one another.

The correlations of Test 9 (sight-screener binocular, one measure) with Tests 1, 2 and 3 are 0.85, 0.82, and 0.86. The slightly lower values suggest that, in the case of near lateral phorias, repeated measures on the sight-screener by the cover technique might be preferable to a single binocular measure.

In an attempt to explain the relatively poor agreement of the ortho-rater scores with those of the other tests, a careful examination of the instrument was made. It was noted that the experimental phoria slides used in this study were not so dark as those of the standard ortho-rater. Because of this, the black septum and the apertures limiting each field were visible against the lighter background of the slide. They were much more noticeable in the near than in the far tests.

Wirt's study[3] demonstrated the importance of rendering invisible all detail other than the phoria slide itself in order not to stimulate excessive convergence. It seemed probable, therefore, that the defect in the ortho-rater slides used in this study might be responsible for the relatively low correlation of the ortho-rater with the other tests of lateral phoria at near.

In order to test this assumption, the phoria slides were replaced with new ones of sufficient density to obscure completely the outlines of the black septum and apertures. A second group of 50 subjects (Series II) was then tested as before on the ortho-rater, sight-screener and rod and scale tests. The correlations of the ortho-rater and sight-screener cover tests with Test 2 (rod and scale cover test) are respectively 0.80 and 0.81. Single binocular measures on the ortho-rater and sight-screener each show correlations of 0.75 with Test 2.

TABLE 5

STANDARD ERRORS OF ESTIMATE OF LATERAL PHORIA AT NEAR

(Prediction of scores on Test 2 (rod and scale, cover test) from scores on other tests)

Test	Standard Error of Estimate, Prism Diopters	
	Series I	Series II
4 (Ortho-rater, cover)	4.01	2.99
5 (Sight-screener, cover)	2.66	2.91
6 (Rod and scale, binoc.)	2.24	2.23
8 (Ortho-rater, binoc.)	4.32	3.24
9 (Sight-screener, binoc.)	3.43	3.28

In Series II, therefore, the ortho-rater and sight-screener scores correlate equally well with the criterion. The correlations of Series II are in general lower than those of Series I, perhaps because the second group included fewer subjects with high degrees of defect.

Limitation of the range of defect in Series II would be expected to reduce the correlation coefficients but should not affect the standard errors of estimate. Significant differences in the standard errors of Series I and Series II are therefore to be expected only for Tests 4 and 8 (orthorater, cover and binocular) in which there was a change in the experimental conditions.

Table 5 gives for each test the standard errors when Test 2 (rod and scale, cover test) is taken as the criterion. For Tests 5, 6, and 9, the values are essentially the same in Series I and Series II. For Tests 4 and 8 (ortho-rater), on the other hand, there is a significant decrease in Series II.

It will be noted that the standard errors for lateral phoria tests at near are greater than those found for the same tests at distance. This is also true of previous studies. Imus, for example, found a standard error of 4.15 prism diopters for prediction of clinical scores of near lateral phoria from an ortho-rater test. Sulzman, Cook, and Bartlett report values of 4.45 for the ortho-rater; 5.06 for the sight-screener.

If lateral phorias at near from −10 to +5 are accepted as passing scores, and examination is made of the results of the various tests by means of the four-fold tables, we find that the sight-screener agrees with the clinical tests as well as they agree with one another. The following tables are typical of the findings of Series I.

		Rod and Scale, Cover	
		Pass	Fail
Phorometer:	Pass	34	0
	Fail	4	12
Sight-screener, cover:	Pass	36	2
	Fail	2	10

In Series I, however, the ortho-rater does not compare favorably with the other tests. Typical tables comparing the ortho-rater with other tests are:

		Rod and Scale, Cover	
		Pass	Fail
Ortho-rater, cover:	Pass	29	3
	Fail	9	9

		Phorometer	
		Pass	Fail
Ortho-rater, binocular:	Pass	26	7
	Fail	8	9

Series II provides data for a comparison of the ortho-rater and the sight-screener with the rod and scale test. In these tests, as mentioned previously, darker slides were used in the ortho-rater to remove convergence stimuli which in Series I might have been responsible for the relatively poor agreement of the ortho-rater with the other tests. Typical results are:

		Rod and Scale, Cover	
		Pass	Fail
Ortho-rater, cover:	Pass	37	0
	Fail	6	7
Ortho-rater, binocular:	Pass	41	0
	Fail	3	6

		Rod and Scale, Cover	
		Pass	Fail
Sight-screener, cover:	Pass	42	1
	Fail	1	6
Sight-screener, binocular:	Pass	42	2
	Fail	1	5

The better agreement of the ortho-rater with the rod and scale test in Series II than

TABLE 6

MEANS AND STANDARD DEVIATIONS OF TESTS OF VERTICAL PHORIA

Test	Distance, Series I 50 Cases		Near, Series I 49 Cases		Near, Series III 60 Cases	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
1 (Phorometer)	+0.01	0.84	−0.11	0.90		
2 (Rod & scale, cover)	+0.05	0.72	−0.02	0.80	+0.11	0.61
3 (Polaroid & grid, cover)	+0.08	0.60	0.00	0.77		
4 (Ortho-rater, cover)	+0.11	0.60	+0.03	0.67	+0.18	0.76
5 (Sight-screener, cover)	−0.03	0.71	−0.01	0.83	+0.02	0.67
6 (Rod & scale, binoc.)	+0.03	0.74	+0.09	0.67	+0.06	0.38
7 (Polaroid & grid, binoc.)	+0.04	0.61	+0.02	0.78		
8 (Ortho-rater, binoc.)	+0.07	0.60	+0.05	0.60	+0.13	0.68
9 (Sight-screener, binoc.)	−0.01	0.70	−0.06	0.77	+0.06	0.60

in Series I is as would be expected from the evidence previously discussed.

C. *Tests of vertical phoria.* Evaluation of the relative merits of the different tests of hyperphoria presents, for two reasons, a somewhat different problem from that involved in tests of lateral phoria.

First, since the possible influence of apparatus convergence is not of importance in the measurement of hyperphoria, the machine tests differ from the clinical tests chiefly in the methods used to present different images to the right and left eyes. There is therefore no valid reason for selecting any particular test as the criterion for the evaluation of other tests.

Secondly, in any unselected group of subjects, significant amounts of hyperphoria occur only rarely. In this study, for example, although efforts were made to include as many subjects as possible with high degrees of muscle imbalance, in the distance tests 42 of the 50 cases, in the near tests 40 had not more than one prism diopter of hyperphoria on any of the nine tests. In an additional 60 subjects, given six tests of near vertical phoria (Series III), 52 had similar non-significant amounts of hyperphoria on all tests.

Table 6 gives the means and standard deviations of each test of far and near vertical phoria. The means are all close to zero, and the standard deviations of the different tests lie between 0.4 and 0.9 prism diopters. Although correlation coefficients were also computed, they have been omitted because it was obvious that they did not provide a reliable basis for evaluation of the different tests. Because of the few subjects with significant degrees of hyperphoria, the correlations can be markedly influenced by the data of a single such individual. In the tests of near phoria, for example, the correlation between Tests 6 and 8 is 0.64 in Series I but in Series III the correlation between the same pair of tests is only 0.25.

A more satisfactory method of evaluating the relative merits of the different tests is provided by data showing the extent to which they agree in the detection of significant amounts of hyperphoria. Table 7 gives the scores of all subjects in Series I and Series III having more than one prism diopter of hyperphoria on at least one of the nine tests. Since no one of these is obviously a better test to use as a standard for the evaluation of the others, the entire battery of tests was used to provide a criterion.

In the last column of the table, F indicates that there was a significant hyperphoria (1.25 prism diopters or more) on at least one half of the tests; P indicates that the hyperphoria was not significant in a majority of the tests. The individual scores marked by an asterisk are those which do not agree with this criterion.

Case 12 was not classified and the data for this subject were not included in the

TABLE 7

SCORES OF SUBJECTS HAVING 1.25 OR MORE PRISM DIOPTERS OF HYPERPHORIA ON ANY TEST

Test No.	1	2	3	4	5	6	7	8	9	
Case No.	Series I, Far, 50 Subjects									
49	+ 3.5	(+3.0)	(+4.0)	(+2.5)	(+2.5)	(+3.0)	(+4.0)	(+2.5)	+2.0	F
15	+14.0	(+3.0)	(+4.0)	+2.0	(+2.5)	(+3.0)	(+4.0)	+2.0	(+2.5)	F
19	− 3.8	(−3.0)	0.0*	−1.5	−1.5	(−3.0)	0.0*	−1.0*	−2.0	F
3	+ 1.25	+1.5	+0.75*	+0.5*	+1.25	+1.75	−1.0*	+0.5*	+1.5	F
12	− 2.4*	−1.5*	+1.0	0.0	−0.25	−1.5*	+1.0	0.0	−0.25	P
21	+ 0.2	0.0	−1.0	+1.5*	0.0	0.0	−1.0	+1.5*	0.0	P
25	0.0	0.0	0.0	−1.25*	−0.5	0.0	0.0	−1.5*	−0.5	P
43	+ 0.1	0.0	+0.5	0.0	+1.0	0.0	+0.5	−0.5	+1.5*	P
	(No. differing from majority)									
	1	1	2	3	0	1	2	4	1	
Case No.	Series I, Near, 49 Subjects									
49	+11.3	(+3.0)	(+4.0)	(+2.5)	(+2.5)	(+3.0)	(+4.0)	(+2.5)	(+2.5)	F
15	+11.0	(+3.0)	+1.0*	(+2.5)	(+2.5)	+0.5*	+1.0*	+1.5	+1.0*	F
19	− 3.5	(−3.0)	−2.0	−1.5	−2.0	(−3.0)	−2.0	−1.0*	−2.0	F
4	− 1.6	−0.75*	−1.0*	−1.5	−1.5	−0.75*	−1.0	−1.5	−1.5	F
12	− 3.0	−2.5	+2.5	0.0	+1.5	−3.0	+2.5	0.0	+1.5	?
24	+ 1.6*	+1.6*	+0.5	+0.5	+0.5	+1.0	+0.75	+0.5	+0.5	P
32	+ 0.3	0.0	0.0	0.0	−1.5*	0.0	0.0	0.0	−1.5*	P
33	− 0.75	0.0	0.0	0.0	−1.5*	0.0	0.0	0.0	−1.5*	P
43	− 0.10	0.0	+1.5*	0.0	+0.75	0.0	+1.5*	0.0	+0.75	P
	(No. differing from majority)									
	1	2	3	0	2	2	3	1	3	
Case No.	Series III, Near, 60 Subjects									
85		(+4.0)		(+2.5)	+2.5	0.0*		+2.0	+2.5	F
76		+0.5*		+2.5	+2.0	+0.5*		+2.5	+2.0	F
62		−0.2		−2.0	−0.5*	−0.5*		−2.0	0.0*	F
103		+1.5*		+1.0	+1.0	+1.0		+1.0	+1.5*	P
65		−0.5		+2.5*	−0.5	−0.5		+2.0*	−0.5	P
92		+2.0*		+1.0	+1.0	+1.5*		+0.5	+1.0	P
104		0.0		0.0	−1.5*	0.0		0.0	−1.5*	P
107		−1.0		−0.5	−1.5*	0.0		0.0	−1.0	P
90		0.0		+2.0*	+1.0	0.0		+1.5*	+1.0	P
	(No. differing from majority)									
		3		2	3	4		2	3	

Note: Hyperphoria scores in parenthesis are just beyond the limits of the instrument and the true scores may be greater than the values shown. In the last column an F indicates that the hyperphoria is greater than 1 prism diopter on half or more of the tests. P indicates that it is one prism diopter or less on more than half of the tests. The individual scores marked by an asterisk * are those which do not agree with this criterion.

analysis because, although the phoria was significant in amount in seven tests, it varied from a left hyperphoria of three prism diopters to a right hyperphoria of 2.5.

Table 7 also shows for each group of subjects the number of instances in which each test differed from the majority. The number of such discrepancies varies from zero to four for the different tests. In interpreting these figures, it should be remembered that the scores of subjects not listed in the table agreed on all tests in showing nonsignificant amounts of hyperphoria.

It is apparent therefore that, in a group of

from 50 to 60 subjects, there may be as many as four whose scores on a single test disagree with the results based on a battery of such tests.

Although the intercorrelations between tests are, in this study, lower for vertical than for lateral phorias, the results summarized in Table 7 indicate that the tests of vertical and of lateral phoria are about equally efficient in the detection of significant defects. The data also show that the ortho-rater and sight-screener tests of hyperphoria are as satisfactory as certain of the commonly used clinical tests.

Summary

The results of the present study support the thesis that, in properly designed tests of lateral phoria, optical simulation of the testing distance is not a significant source of error. Proper design requires that the test targets be seen against a dark, undifferentiated background. The amount of accommodation is then determined solely by the optical distance of the targets, and there are, moreover, no fusion stimuli which can influence the convergence of the eyes.

Under these conditions, the ortho-rater and the sight-screener tests of lateral phoria are as highly correlated with accepted clinical tests as these are with one another. At distance, a single binocular measure of lateral phoria on the ortho-rater or the sight-screener gives almost as close agreement with the clinical tests as does a score based on the average of four successive measurements obtained by the cover technique.

Lateral phorias at near are more variable and, for this reason, it is perhaps advisable that the score be based on an average of several measures. The agreement between different tests of vertical phoria was, in this study, not as great as that found for the tests of lateral phoria.

Analysis of the data on the basis of selected pass-fail criteria shows that either of the two machine tests investigated in this study may be used as a selection test which will, with few exceptions, qualify the same individuals as are qualified by one of the clinical tests.

In the sight-screener test of lateral phoria at distance, the allowance for an assumed apparatus convergence should have been omitted, since without this allowance the mean lateral phoria at simulated distance agrees closely with that found at true distance.

The different types of test are about equally satisfactory in detecting significant amounts of vertical phoria.

Each of the tests occasionally fails to detect a moderate hyperphoria. For this reason, if only one type of test is used, normal findings should, if possible, be confirmed by one or more retests.

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THE RESULTS OF VARIOUS OPERATIVE PROCEDURES IN ACUTE CONGESTIVE GLAUCOMA*

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The immediate objectives of the treatment of acute glaucoma are threefold: (1) To conserve vision, (2) to relieve pain, (3) to effect a safe and permanent arrest of the condition with the least possible risk of complications. The survey here reported was undertaken to determine which of the various operative procedures offered the best prospect of attaining the third objective.

MATERIAL

The material on which this study is based consists of those patients with acute congestive glaucoma, admitted to the Wilmer Institute between the years 1930 and 1946, who had an initial ocular tension of at least over 50 mm. Hg (Schiøtz) and on whom there was a minimum follow-up period of six months; 157 cases were found which filled these criteria.

These cases fell into three general groups.

First, patients admitted late in the course of the disease, often completely blind, with advanced or recurrent inflammatory glaucoma, whose eyes showed organic changes already so established that the usual and conventional methods of operative interference were either impossible or undesirable. These cases were, as a rule, operated by posterior sclerotomy or sclerectomy, followed either immediately or shortly afterward by a supplemental operation on the anterior ocular segment. In a few cases trephinations were done.

Second, a group of recurrent cases which had, as a rule, been uncontrolled by miotics or previous operations, in which the organic changes in the eye were not advanced, and which, in general, still offered a fair prognosis for control of the glaucoma and some retention of vision. In this group, iridencleisis was usually the operation of choice.

Third, a group of patients usually in their first attack, many of whom could be controlled by miotics, in whom there were few, if any, established organic changes, and who offered therefore excellent prospects for the control of the disease.

RESULTS

GROUP I

The patients in this group are especially interesting because, although their cases were almost hopeless from the beginning, they illustrate the severe complications which often follow the methods of operative interference employed.

A. *Posterior sclerotomy or sclerectomy combined with an anterior segment operation.* The chief advantage of posterior sclerotomy is a deepening of the anterior chamber for later entrance into the anterior segment. To counter this advantage there are numerous complications.

The additional trauma to the eye may lead to vitreous hemorrhage, detached retina, and a further increase in the inflammatory reaction—all of which work against a successful result in glaucoma surgery. In only three cases in which posterior sclerotomy or posterior sclerectomy was employed, was the operative effort successful.

Thirty-two cases of acute glaucoma were operated by posterior sclerectomy or posterior sclerotomy, with a combination of such operations as iridectomy, iridencleisis, or trephination, 23 of these cases were operated upon with posterior sclerotomy and nine with posterior sclerectomy, plus iridectomy, iridencleisis, and trephination. The secondary operation in the three successful cases were two iridencleises and one trephination.

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Among the 29 failures, there were 15 trephinations, four iridectomies, and 10 iridencleises as the secondary operation. The cause of failure in four cases was vitreous hemorrhage; in one case detachment of retina; and in two cases, cataract. In these seven cases, as well as the remaining 22 cases, the tension rose and eventually only bare light perception or less remained.

The series of cases that had posterior sclerotomy were compared with those in which posterior sclerectomy was done, either as a single operation or in combination with trephination, iridencleisis, or iridectomy.

Of the nine posterior sclerectomies, all failed to control the tension. The postoperative course in each case was stormy. In all of the cases, the tension rose and was often accompanied by a low-grade iritis. Seven of the cases showed anterior-chamber or vitreous hemorrhage. In five of these cases enucleation eventually had to be performed.

The pathology records for the enucleated eyes report vitreous hemorrhage, choroidal hemorrhage, detached retina, iritis, and endophthalmitis. Dislocation of the lens system into the vitreous and prolonged hypotony were clinically observed as additional complications.

GROUP II

A. *Iridencleisis.* Iridencleisis was used in patients, who had had previous acute attacks of glaucoma, and in most of those cases in which the intraocular pressure did not respond to the use of miotics. The cases might be classed as severe in so far as the glaucomatous status was concerned.

There were 58 iridencleises in this group. Of these, 78 percent were successful and 22 percent unsuccessful.

Of the 78 percent, or 44 cases, that were successful, 16 were successful after poor preoperative response to miotics; while 28 were successful when the operation was performed after the tension fell to normal in response to the use of miotics. The failures were equally distributed whether or not the eye responded to miotics.

The complications noted among the failures were delayed reformation of the anterior chamber, the formation of anterior peripheral synechias, occasional secondary cataract, and failure to control tension.

B. *Trephinations.* In the 10 cases operated by trephination, success occurred in only two cases.

In the eight failures the following complications occurred: (1) The intraocular pressure again rose following a period of inflammation; (2) there was a subsequent formation of complicated cataract; (3) herniation of the ciliary body and the lens into the wound occurred; and (4) rupture of the lens capsule often blocked the trephine opening. The factors precipitating this last-named complication appeared to be the small size of the opening and the sudden release of great pressure.

In three cases of simple iridectomy, there were two successes. Iridectomy was a procedure usually reserved for those patients in their initial attack of glaucoma uncomplicated by other pathologic conditions.

GROUP III

Forty-six cases were operated upon by iridectomy. There were 37, or 81 percent, successes. If only those cases in which the patient was in his first attack of glaucoma, and in which the intraocular pressure fell to normal prior to operation are considered, this procedure was successful in 90 percent of the cases.

The failures in iridectomy occurred in patients who had had two or more congestive attacks, or in patients in whom the initial ocular tension did not respond to the use of miotics. Even so, in three of the failures, the tension was controlled for over six months. There was, however, a subsequent rise of tension that necessitated reoperation. The possibility of the pressure rising some months after an apparently successful iridectomy should be considered strongly, since it

occurred in six percent of the cases reviewed.

Seven of the eight failures were in patients who failed to respond to preoperative miotics; conversely, only one patient who responded to miotics failed to obtain a successful result.

Eight patients were operated upon by iridencleisis in this group of patients with acute uncomplicated glaucoma. Six of these patients suffered no complications and retained useful vision and full fields. In the other two cases, cataract was an early complication. One other case developed cataract nine months after surgery, and there was a low-grade iritis with rise of tension in the remaining failure.

Comment

The first point brought out by this analysis is that posterior sclerotomy and sclerectomy in acute congestive glaucoma are anything but benign operative procedures. Failures occurred in 29 out of 32 cases so operated.

It is true that these patients all presented a most unfavorable preoperative prognosis, with advanced inflammatory glaucoma, organic changes in the eye, and, usually, flat anterior chambers. Although in these cases there appeared to be no alternative other than some preliminary operation on the posterior segment, the conclusion is nevertheless inescapable that these already inflamed eyes, with dilated and engorged vessels, were not able to withstand the insult incident to the operative procedure.

The second point is that trephination is apparently not a propitious selection for anterior segment operation in acute inflammatory glaucoma. The forward displacement of the lens system tends to block the trephine opening and late rupture of the lens capsule is not infrequent.

The good results following iridectomy in favorable cases were to be expected, and are in line with other reports on the use of this operation in acute inflammatory glaucoma. What is interesting, however, is that almost equally good results were obtained with iridencleisis in a group of cases which, on the whole, offered a more gloomy preoperative prognosis. The figures here reported would indicate that in such cases iridencleisis may be the operation of choice.

A number of other interesting findings were noted in the review of these cases, and the most striking was the bilaterality of the disease. Acute glaucoma occurred in both eyes in 72 percent of the cases, and both eyes were affected within six months. If the subsequent course of the patients with unilateral glaucoma were known, this figure might well be higher. In two cases in which the acute glaucoma was unilateral and in which the operation did not succeed, a malignant melanoma was found after it was necessary to enucleate the eye.

Summary

The operative results in 157 cases of acute glaucoma are reported.

Of 23 cases operated upon by posterior sclerotomy combined with various anterior segment operations, only three (13 percent) were successful, while 20 cases (87 percent) were failures. Nine patients operated by posterior sclerectomy with some secondary operation all showed unsuccessful results.

Of 10 patients operated on by the trephining operation, only two cases were successful.

Admittedly, the cases in this group were advanced and severe cases with a poor operative prognosis from any operation.

Among 46 patients operated by iridectomy, there were successful results in 81 percent.

The 58 patients, operated by iridencleisis, represented a more severe group of cases than those operated by iridectomy. There were 78 percent successes in this group.

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OPTICAL BEHAVIOR OF SCLERA TRANSPLANTED INTO CORNEA*

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The structure of the stroma of the cornea and the sclera shows a striking similarity. Both are composed of lamellae built up of bundles of collagenous fibrils.

Slight differences in structure may, however, be demonstrated by the ordinary histologic technique—the scleral fibrils are packed closer and can only be seen as separated fibrils by impregnation methods (Laguesse's staining). The corneal lamellae run regularly parallel to the corneal surface, the scleral bundles show many oblique and transverse crisscrossing loops.

The sclera also contains numerous elastic fibers which can be easily demonstrated by orceine staining. In the cornea which is also stated to contain elastic fibers (Tartuferi[1]) we could not clearly observe these fibers with the orceine staining. In any case, there is a marked difference with regard to elastic fibers in the cornea and sclera, in orceine-stained specimens.

The most essential difference between cornea and sclera consists, however, in the different optical properties. The histologic differences between cornea and sclera do not explain the different optical behavior, as was demonstrated by F. P. Fischer.

Fischer[2] analyzed an observation of Kahn, who observed that the luxated eyeball of a rabbit showed dark patches after some time. Fischer proved that these patches were a sequela of dehydration of the sclera. It was even possible to read fine print through this dehydrated sclera.

The transparent sclera showed the same Tyndall effect as the cornea in the optic section on slitlamp examination. It is equally well known that, when the cornea takes up water, this affects the transparency, and the cornea eventually becomes opaque (Fischer,[3] Cogan[4]).

From these findings it is evident that the water content is very important for the optical behavior of cornea and sclera.

Cogan and Kinsey[5] concluded from experiments on excised corneas of cats that the cornea is situated between two semipermeable membranes, and is held in a state of dehydration by osmotic forces of the aqueous and tears which are supposed by them to be hypertonic to the corneal fluid.

They think that the difference between cornea and sclera is explained by the fact that the cornea is held in a state of dehydration by its two semipermeable membranes, the epithelium and endothelium, and the sclera is swollen to its full water content. If the sclera is dehydrated, it becomes transparent, just as the normal cornea.

As criticism to Cogan's conclusions, it may be said that these experiments were performed on excised corneas, and that the conditions in living tissue are different (Yap Kie Tiong[6]).

In the course of experiments on corneal transplantation, I came upon a method which proved to be extremely useful for the investigation of the optical behavior of sclera and cornea. I performed autotransplantations of sclera into cornea in rabbits. A preliminary report of these experiments has appeared in Ophthalmologica.[7]

Only recently I learned that Thomas[8] was the first to transplant scleral tissue into cornea, whereas Castroviejo[9] transplanted grafts which consisted partly of cornea and partly of sclera. Both used homografts. Thomas noticed that in some cases the scleral graft became partly transparent; in Castroviejo's

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experiments the whole graft of cornea and sclera became opaque.

In my experiments, it was observed that autotransplants of sclera into cornea tend to lose their opacity and to become more or less transparent. The report of these experiments will be given in this paper.

Experiments

Fifteen rabbits were operated on. The first operations were done under intravenous somnifen anesthesia, but this was soon abandoned as the tolerance of the animals varied considerably, and some died during or after the anesthesia. The greater part was operated with local anesthesia only—instillation of cocaine (two percent) and adrenalin, and atropine for mydriasis.

The animals were fastened on an operating table for rabbits and remained always quiet during operation, provided an assistant put a hand on their backs. This seems to reassure the animals and provides a sort of mental narcosis. Precautions as to sterility of instruments and animals were the same as observed in ordinary ophthalmic surgery.

A speculum was inserted in the left eye. A traction suture was applied to the limbus in the superoposterior quadrant. The conjunctiva was incised at the limbus and dissected in this quadrant. A scleral round was trephined at a distance of two to three mm. from the limbus. A Grieshaber trephine, 4.1 or 5.0 mm. in diameter, was used. The trephining was finished, if necessary, with Girardet's scissors.

The excised piece of sclera was then cleared, at the inner side, of the pigment of the lamina fusca by means of a spatula and fine forceps.

The speculum was then inserted in the right eye of the same animal. The fixation of the eye was facilitated by two traction sutures through the inferior and superior rectus muscles. With the same trephine, the place was marked on the cornea where the scleral round was to be inserted. Fluorescein was instilled. Then the corneal sutures were applied.

I tried Thomas's methods, as well as the crossed threads of Franceschetti and Castroviejo's method. The last method of suturing gave the best results and was used in most of the cases.

After the cornea was trephined—the trephining being completed, if necessary, with the scissors of Girardet—the scleral round was inserted and the sutures were pulled and tied. In some cases the sclera was inserted with the inner side (lamina fusca) out.

Coagulation of the aqueous humor, which occurs in the rabbit's eye and may interfere with a correct performance of the operation, was prevented by instillation of sodium citrate (3.8 percent) during the trephining.

The anterior chamber was often restored at the end of the operation. The eyelids were closed by sutures. All sutures were removed after five days.

The grafts healed perfectly except in one case, in which malunion of the graft resulted in infection and subsequent loss of the eye. In a few instances an anterior synechia developed which disappeared in all cases after few days or two weeks.

The epithelization of the graft was followed up by staining with fluorescein. In most cases the graft was completely covered by the corneal epithelium four to six days after removal of the sutures, but in some cases it took a longer time, in one case even 29 days.

The first reaction of the recipient cornea consisted in the formation of a white ring around the transplant, separated from the latter by a perfectly clear zone (fig. 1-B). On slitlamp examination, this white ring consisted of a cloudiness of the deeper layers of the recipient cornea. The white ring is usually most prominent in the third week after the operation. The clear zone between the transplant and the white ring then gradually becomes opaque, and the white ring is no

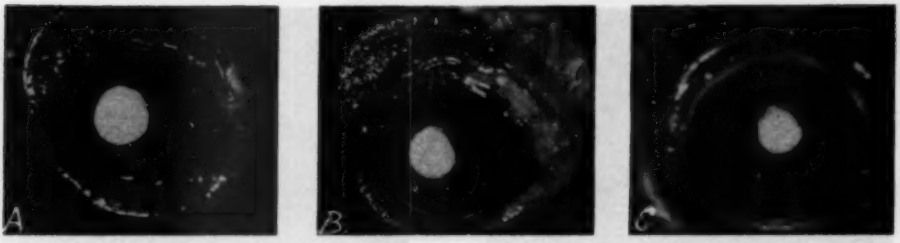

Fig. 1 (Winkelman). Rabbit 4 was operated on January 5, 1950. (A) Condition on January 13, 1950. (B) On January 24, 1950, a white ring had developed in the cornea around the transplant, separated from the latter by a transparent zone. (C) By February 6, 1950, the transparent zone had disappeared.

longer visible (fig. 1-C).

Other interesting changes now begin to occur in the transplant. The scleral graft partly begins to lose its dense white aspect and becomes transparent in some places. This process gradually progresses until, in some cases, the whole graft becomes transparent. The transparency, however, does not reach the ideal transparency of the cornea.

It became possible to observe the iris and pupil through the transplant, and, with the slitlamp, an optic section could be examined, which showed a Tyndall effect similar to that of the cornea. This reminds us of Fischer's findings[2] on dehydrated sclera.

The clearing of the transplant occurred in two ways. First, the transplant became smaller, because a clearing occurred from the border toward the center of the graft. Sometimes this process occurred along the circumference of the graft (fig. 2). More often, however, only a part of the circumference was involved, thus changing the shape of the graft; for instance, from circular it became elliptic, or it assumed the shape of a half moon (fig. 3).

The second possibility was that, within the opaque tissue of the grafts, transparent spots developed, which gradually enlarged and finally reached the border of the graft. Often these two ways of clearing were associated, and the graft became transparent in several places simultaneously (fig. 4).

Vascular ingrowth into the cornea, and subsequently into the transplant, occurred in most of the animals; only in one, no vessels at all were seen during six months following the operation. This same animal showed the most striking clearing of the graft.

In some animals, vascularization was mini-

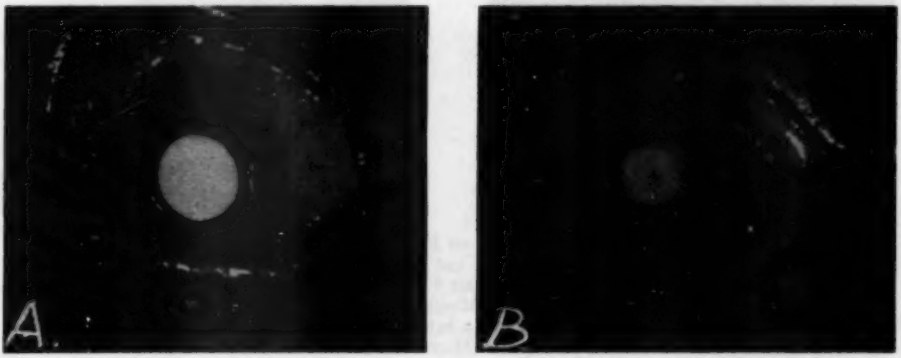

Fig. 2 (Winkelman). Rabbit 5 was operated on January 6, 1950. (A) Condition on January 13, 1950. (B) By February 6, 1950, the opaque tissue of the scleral graft had concentrically narrowed and was replaced by semitransparent tissue.

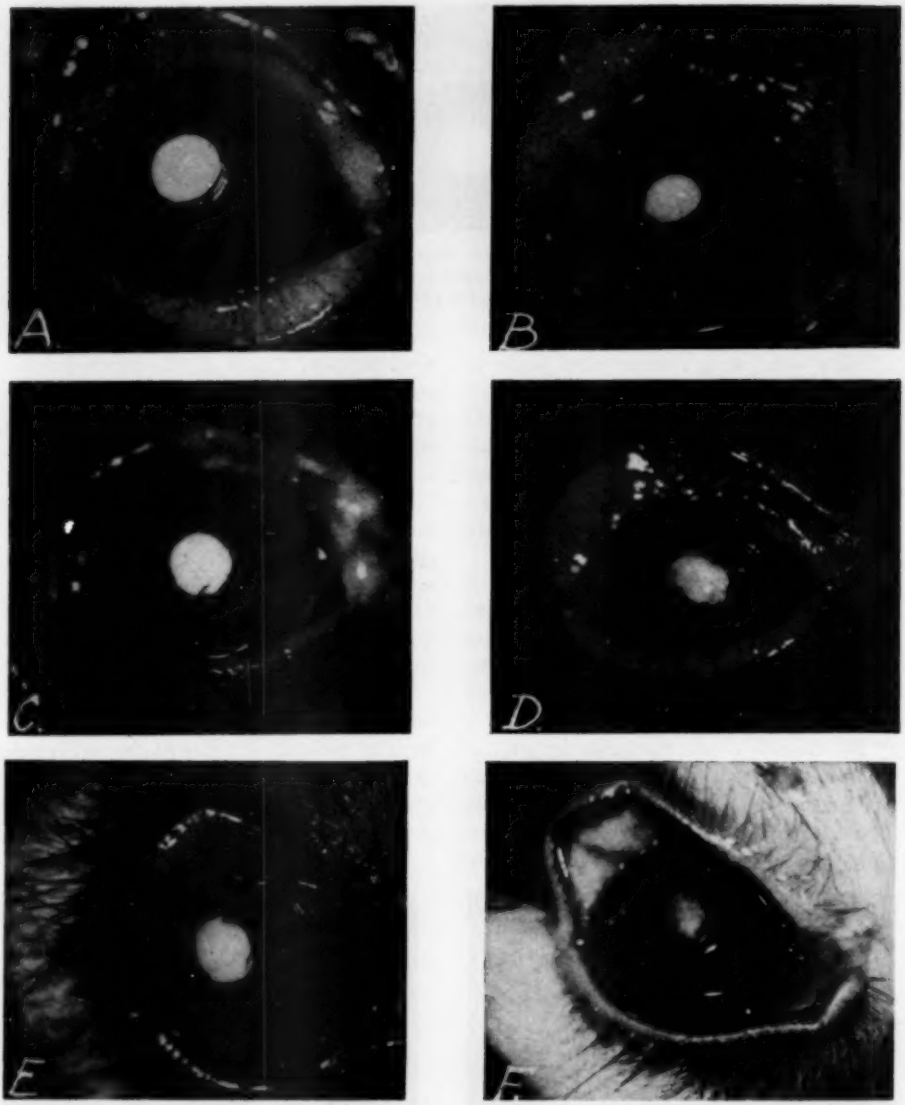

Fig. 3 (Winkelman). Rabbit 12 was operated on February 13, 1950. (A) Condition on February 20, 1950. (B) By March 6, 1950, the circular graft had become elliptic because it had become transparent along the superior and inferior borders. (C) Rabbit 9 was operated on February 5, 1950, and this picture shows the condition on February 15th. (D) By March 13, 1950, the graft had become transparent in the left lower quadrant, thus assuming the shape of a half moon. (E) Rabbit 14 was operated on February 22, 1950, and this picture shows the condition on March 6th. (F) By May 29, 1950, the graft had cleared along the circumference, thus assuming an irregular shape.

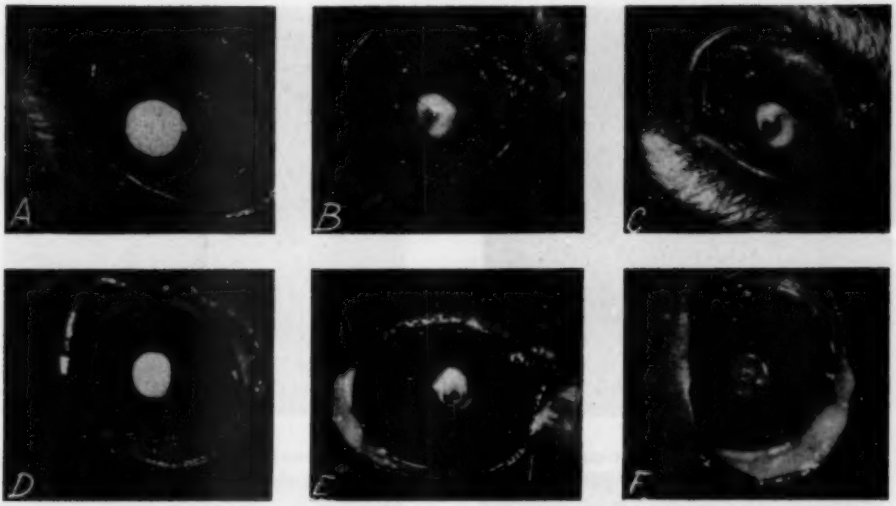

Fig. 4 (Winkelman). Rabbit 6 was operated on January 9, 1950. (A) Condition on January 17, 1950. (B) On March 6, 1950, the graft was transparent along the border, and a transparent spot had also appeared in the center. (C) By May 29, 1950, the central transparent spot had enlarged and become confluent with the transparent spots at the border. (D) Rabbit 3 was operated on January 4, 1950, and by January 13th, the appearance was as shown in this picture. (E) By February 21, 1950, the graft had become transparent at the borders as well as in the lower half. (F) By March 27, 1950, nearly all the opaque scleral tissue had disappeared and was replaced by a transparent macula.

mal, or it appeared late, after considerable clearing of the graft had already been brought about. In others, it appeared shortly after the operation, but the vessels later became empty or disappeared completely.

As first sign of vascularization, deep and superficial vessels were seen at the limbus over a small area or along a considerable extent. These vessels gradually progressed, until they reached the transplant which subsequently became vascularized.

In some cases the whole transplant became invaded by vessels, in others only one or two vessels were seen in a small part of the graft. I had the impression that vascularization had little, if any, influence on the process of clearing of the graft. The observations on vascularization are summarized in Table 1.

Vascularity was most pronounced in Rabbits 13 and 15, both albino rabbits; albino rabbits seemed to tolerate the operation less well than other animals and showed a strong vascular reaction (fig. 5).

Slitlamp examination of the grafts revealed some interesting features. The first changes to be noted were a splitting up of

TABLE 1

SUMMARY OF OBSERVATIONS ON VASCULARIZATION

Rabbit No.	Weeks after Operation	Amount of Vascularization	Further Developments
3	—	None	Observed 6 mo.
4	2.5	Slight	Unchanged in 5 mo.
5	2	Medium	Less in 5 mo.
6	4	Extensive	Disappears in 5 mo.
8	2.5	Slight	Worse in 4.5 mo.
9	4	Slight	Medium in 2 wks.
10	1	Slight	Medium in 1 mo., then disappears
11	6	Extensive	Unchanged in 4 mo.
12	2	Medium	Unchanged in 4 mo.
13	3	Extensive	Nearly unchanged in 3 mo.
14	12	Slight	Unchanged in 1 mo.
15	2	Extensive	Unchanged in 3 mo.
16	12	Slight	Unchanged in 1 mo.
17	3	Slight	Unchanged in 3 mo.

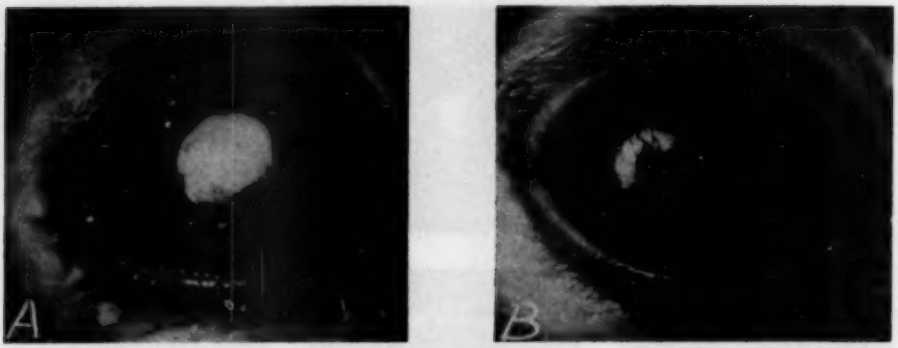

Fig. 5 (Winkelman). Rabbit 13 was operated on February 20, 1950. (A) Condition on March 6, 1950. (B) By March 20, 1950, the graft had been invaded by extensive vascularization. Part of it had become semitransparent.

the scleral fibers—the clear-cut borders of the graft became indistinct and, the margin of the transplant showed a frayed aspect.

These splitting marginal scleral fibers were seen to lose themselves in the surrounding corneal tissue which seemed to penetrate into the grafts between the remaining scleral fibers (fig. 6). This process progressed continually.

Thin spots also appeared in other places of the graft and gave it an aspect similar to worn-out clothes—the individual fibers became visible, separated by transparent tissue. This is demonstrated in Figure 6-C and F.

The clearing of the graft sometimes progresses rapidly. Strands of scleral fibers, visible on a certain day, had already become invisible and transparent a few days later, as is shown in Figure 6-C and D, which were taken within an interlude of three days. The end result is a transparent macula which, however, is less transparent than normal cornea.

In some instances, the scleral transplant had been inserted "reversed," that is, the lamina fusca of the scleral graft was then on the epithelial side of the recipient cornea. They healed as well as the other grafts, and the fact that the concave curvature was now on the outside made no difference in the final appearance.

Interesting observations were made on these "reversed" transplants. Some pigment of the lamina fusca had been left on the scleral graft and could be seen lying under the newly formed epithelium on the opaque scleral tissue. In the course of the clearing of the transplant, these pigment granules were seen lying in perfectly transparent tissue; whereas, some opaque scleral tissue was still seen behind them. This suggested that the layers which contained the pigment had become transparent before the other layers.

How should these findings be explained? As I have pointed out in a previous article,[7] two possibilities should be considered: (1) Either the scleral tissue is replaced by collagenous fibers from the recipient cornea or

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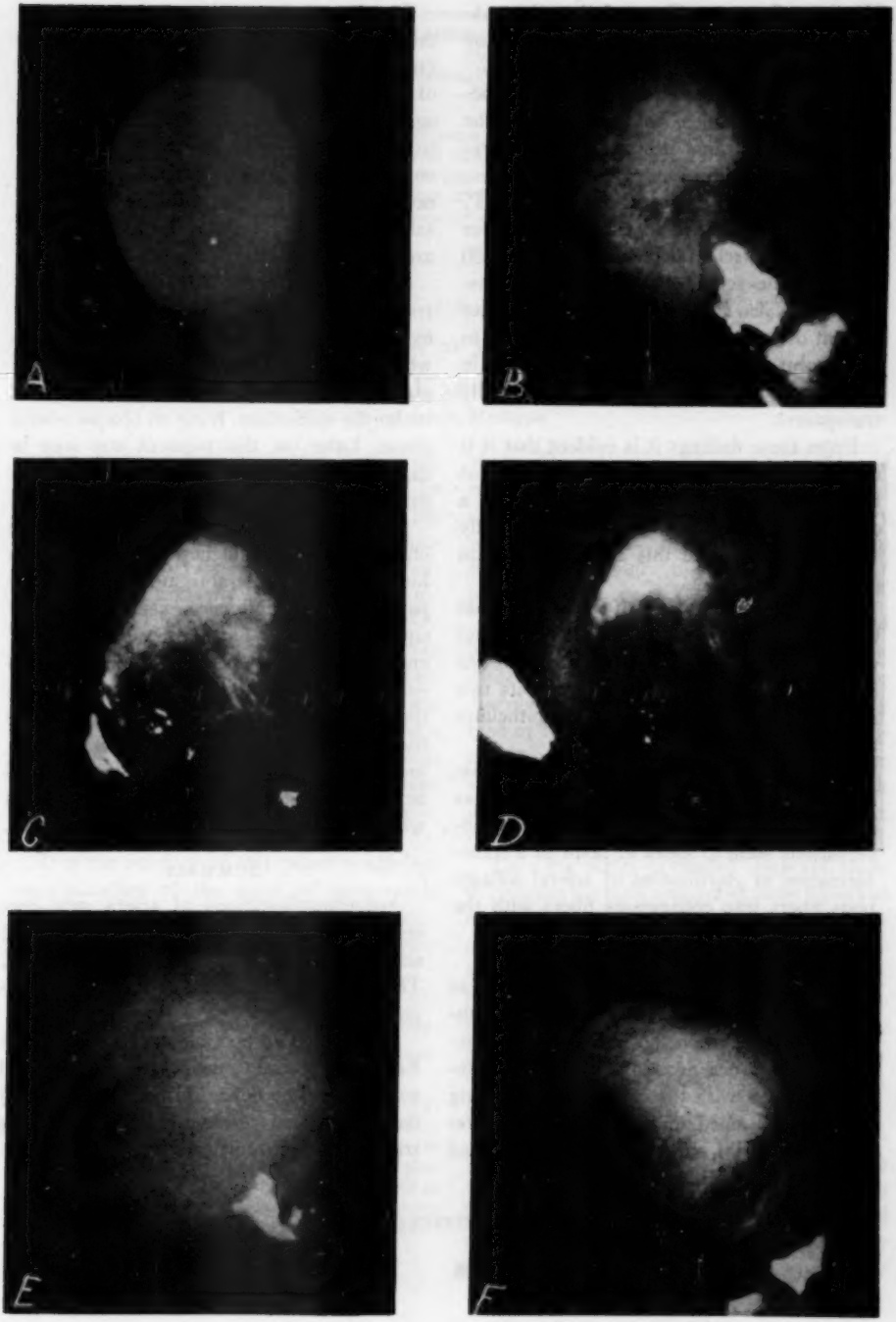
Fig. 6 (Winkelman). Rabbit 3 was operated on January 4, 1950. (A) The condition on January 14th. (B) On February 3, 1950, the graft showed a frayed aspect at the right border. Transparent tissue was seen between the split-up scleral fibers. (C) By February 21, 1950, the graft showed an aspect similar to worn-out clothes. The split-up scleral fibers were separated by transparent tissue. (D) February 23rd, a marked diminishing of the opaque scleral tissue had taken place in two days. (E) Rabbit 14 was operated on February 22, 1950, and this picture shows the condition on March 20th. The scleral graft had begun to clear at the left border. (F) By June 16, 1950, the graft showed the worn-clothes appearance. The scleral fibers were gradually splitting up and becoming transparent.


A
B
C
D
E
F

(2) the collagenous fibers of the sclera assume the properties of collagenous fibers of the cornea.

Thomas thought that the first process occurs. From his slides, he concluded that the scleral fibers became necrotic and were replaced by corneal fibers.

I have already pointed out that F. P. Fischer[2] demonstrated that, when the water content of the sclera decreases (by about 30 percent), the scleral tissue becomes transparent. He also showed that, when the water content of sclera is increased by about 15 to 20 percent by immersion of the sclera in acid or alkaline solutions, it becomes equally transparent.

From these findings it is evident that it is not impossible for the collagenous tissue of the sclera to become transparent and that a change of the water content is apparently sufficient to produce this change in optical properties.

Cogan and Kinsey[4] are of the opinion that the optical difference between cornea and sclera is explained by the fact that the cornea is held in a state of dehydration by its two semipermeable membranes, the epithelium and the endothelium.

In my experiments scleral connective tissue was subjected to the same conditions as corneal connective tissue. My clinical observations seem to speak in favor of a transformation or clarification of scleral collagenous fibers into collagenous fibers with the optical properties of corneal fibers.

Arguments in favor of this opinion are:

No signs of necrosis were seen in these experiments. There was no loss of substance, no ulceration, no inflammatory reaction. The cornea around the transplant remained clear, with the exception of the ring already mentioned, and did not show any reaction, as might have happened if there had been necrosis of the scleral tissue.

The fact that sometimes a large part of the graft became transparent in a few days (fig. 6-C and D) speaks for a transformation of scleral fibers. It is rather difficult to imagine how a large part of necrotic scleral tissue could be replaced by newly formed corneal fibers in a few days! Necrosis would not induce the gradual thinning out of the scleral fibers, but would affect circumscribed areas of the transplant.

Another argument for the process of transformation or clarification was furnished by the behavior of the scleral transplants which had been inserted "reversed." The pigment of the lamina fusca was first seen under the epithelium, lying on opaque scleral tissue. Later on, this pigment was seen in the same place, but now it was situated in perfectly transparent tissue.

Though no proof can be given by clinical observation alone, all these findings seem to indicate that the scleral tissue becomes transparent by some influence exerted by the recipient cornea, or by the new formation of endothelium, a Descemet's membrane, and epithelium by the recipient cornea, and that the connective tissue of the sclera assumes the character of corneal connective tissue. A more detailed discussion of this problem will be given in the second part of this work, in which the histologic findings will be reported.

Summary

Autotransplantations of sclera onto corneas were performed in rabbits. The opaque scleral tissue gradually became transparent. The clinical development of the grafts is reported.

There are two possible explanations: (1) Either the scleral tissue became necrotic and was replaced by newly formed fibrils, or (2) the collagenous fibrils of the sclera were transformed into corneal fibrils.

Schuytstraat 64.

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THE OCULAR FINDINGS OF INTRACRANIAL TUMOR*

A STUDY OF 358 CASES

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The diagnosis and successful localization of intracranial neoplasms should ideally be the result of close coöperation between the neurosurgeon, the neurologist, and the ophthalmologist. Such a relationship has been enjoyed at the University Hospital of the University of Michigan, where the neurosurgery and neurology departments routinely refer the great majority of their suspected cases of intracranial pathology for ophthalmologic consultation. There has thus been afforded a somewhat unique opportunity to establish a proper background upon which the neurologist or neurosurgeon may rely in reaching his diagnosis.

It is the purpose of this paper to attempt an evaluation of the signs of intracranial neoplasm which are encountered by the ophthalmologist from the standpoint of their significance in diagnosis.

A total of 358 cases will be presented. Of these 344 were operated upon and the pathologic diagnosis confirmed by microscopic study. The remaining 14 cases were those in which the diagnosis was within the limits of certainty but in which it was felt surgery would not be advantageous. The latter instances fell mainly under the heading of pinealoma.

The original series of records was selected by the Division of Medical Statistics to include representative series of each major diagnostic group, either by location or by type of tumor. These were tabulated according to ophthalmologic findings. The individual findings were then analyzed according to tumor location, as will be noted from the accompanying tables.

Thus the series presented does not claim to embrace the total number of cases observed during a given period of time, nor does it attempt to include all the cases of any one tumor type during such an interval. Practically all of the records studied were of patients seen within the past 10 years. When a particular finding was not noted for a tumor location, it has been omitted from the appropriate table.

The final selection of cases whose completeness warranted their inclusion in this study is presented in Table 1 according to location of the tumor. Those instances listed as "diffuse" involvement were cases in which the tumor involved more than two major

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† By invitation.

areas. The remaining subdivisions of the table are self-explanatory. This grouping does not claim any significance with regard to the relative incidence of brain tumor by local sites.

The ocular findings to be analyzed are (1) papilledema, (2) optic atrophy, (3) visual field changes, (4) pupillary abnormalities, and (5) disorders of ocular motility.

The incidence of papilledema was 59.5 percent, this finding being reported in 213 of the 358 cases. Where the tumors could be classified as located above the tentorium, papilledema was evident in 53.3 percent (137 out of a total of 257 cases). Those located subtentorially showed papilledema in 76 out of 101 cases, an incident of 75.2 percent. Papilledema was reported to be bilateral in 205 of the 213 individuals. In only 14 cases was there a difference in amount of elevation of the nervehead between the two eyes sufficient to warrant its mention in the hospital records.

The incidence of optic atrophy was 12 percent among the cases studied. There were 25 instances in which the optic-nerve changes were classified as secondary atrophy. Those diagnosed as primary optic atrophy totaled 17 cases. In both types of atrophy the greater number showed changes in both eyes. The findings by location of the tumor are given in Table 2.

The visual field findings are listed in Table 3. A visual field examination was performed in 231 of the 358 cases. Changes in the fields of vision were recorded in 104 of the 231 examinations, or in slightly less than half. The specific findings for each group of tumors may be noted in the table. Almost without exception there were positive visual field findings in certain cases regardless of tumor location. Although too few cases were found to warrant inclusion in the table, the incidence of improvement of the visual fields after surgery was small. It was noted according to further perimetry or to report in

TABLE 1

PAPILLEDEMA

Tumor Location	Number of Cases	Number with Papilledema	Percentage	Bilateral	Unilateral
Frontal lobe	66	30	45.4	29	1
Temporal lobe	29	15	51.7	15	—
Parietal lobe	25	13	52.0	13	—
Occipital lobe	5	4	80.0	4	—
Frontoparietal	18	9	50.0	7	2
Temporoparietal	17	10	58.8	10	—
Parieto-occipital	11	9	81.8	9	—
Frontotemporal	7	3	42.9	3	—
Cerebellum	58	44	76.2	44	—
Pineal gland	16	10	62.5	10	—
Third ventricle	7	5	71.0	5	—
Lateral ventricle	9	7	77.7	6	1
Fourth ventricle	16	12	75.0	12	—
Pons and medulla	6	5	83.3	5	—
Midbrain and pons	10	6	60.0	5	1
Posterior fossa	5	4	80.0	4	—
Corpus callosum	5	2	40.0	2	—
Basal ganglia	5	3	60.0	3	—
Cerebellopontine angle	6	5	83.3	5	—
Diffuse	10	7	70.0	7	—
Optic chiasm and nerve	9	5	55.5	3	2
Pituitary and craniopharyngioma	11	1	9.1	1	—
Sphenoidal wing meningioma	7	4	57.1	3	1
Totals	358	213	59.5	205	8

TABLE 2

OPTIC ATROPHY

Location of Tumor	Primary Atrophy		Secondary Atrophy		Total
	Bilateral	Unilateral	Bilateral	Unilateral	
Frontal	2	—	5	—	7
Occipital	—	—	1	—	1
Frontoparietal	—	2*	—	—	2
Cerebellum	1	—	6	—	7
Pineal	1	—	5	—	6
Third ventricle	—	—	1	—	1
Lateral ventricle	—	1†	1	1	3
Fourth ventricle	—	—	2	—	2
Basal ganglia	—	—	1	—	1
Diffuse	—	—	1	—	1
Optic chiasm and nerve	2	2	—	—	4
Sphenoidal wing meningioma	—	1*	—	—	1
Pituitary and craniopharyngioma	3	1	—	—	4
Midbrain and pons	1	—	—	—	1
Cerebellopontine angle	—	—	1	—	1
Totals	10	7	24	1	42

* Foster Kennedy syndrome.
† ? Early Foster Kennedy syndrome

TABLE 3

VISUAL FIELD FINDINGS

Location of Tumor	Fields Done	Homonymous Hemianopia	Macula Split	Macula Spared	Bitemporal Hemianopia	Quadrantanopia	Peripheral Constriction	Central Scotoma	Binasal Hemianopia
Frontal	40	2	—	1	—	—	7	1	—
Temporal	16	9	—	5	—	1	1	—	—
Parietal	22	5	—	—	—	—	1	—	—
Occipital	5	3	—	2	—	1	—	—	—
Frontoparietal	14	1	—	1	—	1	1	—	—
Temporoparietal	9	5	—	2	—	—	—	—	—
Parieto-occipital	8	4	—	2	—	2	—	—	—
Frontotemporal	5	—	—	—	—	—	1	—	—
Cerebellum	23	1	1	—	—	—	1	—	—
Pineal gland	10	1	—	—	—	—	2	—	—
Third ventricle	4	—	—	—	—	1	—	—	—
Lateral ventricle	7	1	1	—	1	1	4	—	—
Fourth ventricle	10	—	—	—	—	—	3	—	—
Pons and medulla	6	—	—	—	—	—	1	—	—
Midbrain and pons	8	—	—	—	—	—	2	—	—
Posterior fossa	3	—	—	—	—	—	—	—	—
Corpus callosum	5	1	—	—	—	—	—	—	—
Basal ganglia	2	—	—	—	—	—	—	—	—
Cerebellopontine angle	4	—	—	—	—	—	1	—	—
Diffuse	7	2	1	—	—	—	1	1	—
Optic chasm and nerve	8	—	—	—	3	—	1	—	2 unilateral
Pituitary and craniopharyngioma	9	—	—	—	8	—	—	—	—
Sphenoidal wing meningioma	6	—	—	—	—	—	1	—	—
Totals:	231	35	3	13	12	7	28	2	2

TABLE 4

ANISOCORIA

Location of Tumor	Anisocoria Present	Larger on Same Side	Larger on Opposite Side
Frontal	7	4	2
Temporal	8	6	2
Occipital	1	—	—
Temporoparietal	3	2	1
Frontotemporal	1	—	1
Cerebellum	9	—	—
Third ventricle	1	—	—
Fourth ventricle	2	—	—
Pons and medulla	3	—	—
Corpus callosum	2	—	—
Basal ganglia	1	—	—
Cerebellopontine angle	1	1	—
Diffuse	1	—	—
Pituitary and craniopharyngioma	1	—	—
Sphenoidal wing meningioma	1	—	—
Totals	42	13	6

the records in only three cases. The poor prognosis of many of the patients undoubtedly is reflected in this finding.

Anisocoria was the only pupillary abnormality thought reliable enough for inclusion in this report. This was mentioned in 42 of the records, an incidence of 12 percent. The lateralization of the pupillary size was unfortunately not mentioned in many cases. The larger pupil was on the same side as the tumor in 13 instances, as compared with six cases in which it was contralateral to the lesion. Table 4 lists the cases in detail.

The movements of the eyes were found to be affected in a fairly large number of the cases studied. Defects of conjugate movement were noted in 20 cases of the group. These are listed in Table 5. Most of these instances occurred in patients in whom the location of the tumor was such as to involve the pathways for ocular movement, either in the frontal lobe or in the brain stem, with particular emphasis upon the group of pineal tumors.

A lack of uniformity of classification as well as inadequate description of particular cases in detail makes the evaluation of nystagmus in this series most difficult. However, it will be noted from Table 6 that the majority of the cases were those in which coordinative mechanisms of the cerebellum, the brain stem, or the motor pathways was likely to be involved. The incidence of nystagmus for the series was 10.9 percent.

Individual muscle palsies occurred in 46 cases of the group. The abducens nerve or nerves were involved in 35, the oculomotor partially affected in 11, and the trochlear in only two patients. Several other cases could not be listed in this way. These included

TABLE 5

CONJUGATE MOVEMENT DEFECTS

Location of Tumor	Upward Gaze Palsy	Lateral Gaze Palsy	Miscellaneous	Total Cases
Frontal	2	1	—	3
Temporal	1	—	1 (weakness all directions)	2
Cerebellum	1	—	—	1
Pineal	8	4*	—	8
Diffuse	1	—	—	1
Optic chiasm and nerve	1	—	—	1
Pituitary and craniopharyngioma	—	1	—	1
Sphenoid wing meningioma	—	1	—	1
Midbrain and pons	1	—	1 (upward and downward gaze)	2
Totals	15	7	2	20

* In 4 of the 8 cases listed.

TABLE 6

NYSTAGMUS

Location of Tumor	Vertical	Horizontal	Mixed Horizontal and Vertical	Miscellaneous	Total
Frontal	—	3	—	1 "central"	4
Temporal	—	1	—	—	1
Occipital	—	1	—	—	1
Cerebellum	1	11	7	1 "ocular"	20
Pineal	1	1	—	—	2
Lateral ventricle	—	1	—	—	1
Fourth ventricle	—	3	1	—	4
Pons and medulla	—	3	—	—	3
Diffuse	—	—	1	—	1
Cerebellopontine angle	—	—	2	—	2
Totals	2	24	11	2	39

paralysis of convergence and complete ophthalmoplegias and may be found in Table 7.

DISCUSSION

The incidence of papilledema found for this series of cases is distinctly lower than that reported in other articles. Van Wagenen[8] found in a series of 145 verified cases of intracranial tumor that over 88 percent developed papilledema. Critchley[1] has reported brain tumor to be associated with papilledema in over 80 percent of cases. The 59.5 percent incidence in the present series seems low by comparison. Truly comparable figures are not available, since the higher figures are given for series of tumors in children, or for consecutive cases over a relatively short period of time. The closest comparison could be made with the report of Paton,[6] who found that papilledema occurred in 80 percent of

TABLE 7

EXTRAOCULAR MUSCLE PALSIES

Location of Tumor	6th Palsy	3rd Palsy	4th Palsy	Miscellaneous	Total Cases
Frontal	2	1 inc.	—	1 ext. ophthalmoplegia O.U.	3
Temporal	2	1 compl.	—	1 compl. ophthalmoplegia O.U.	3
Frontoparietal	1	—	—	—	1
Temporoparietal	2	1 inc.	—	—	3
Cerebellum	8	5 inc.	—	2 convergence palsy	13
Pineal	5	1 inc.	—	—	6
Lateral ventricle	1	—	—	—	1
Fourth ventricle	2	1 inc.	—	1 ? convergence palsy	3
Pons and medulla	3	—	—	—	3
Midbrain and pons	1	—	—	2 convergence palsy	1
Basal ganglia	2	1	1	—	4
Diffuse	2	—	—	—	2
Optic nerve and chiasm	2	—	—	—	2
Pituitary and craniopharyngioma	1	—	1	—	2
Sphenoidal wing meningioma	1	—	—	—	1
Totals	35	11	2		48

intracranial tumors in a series of 252 cases.

The discrepancy between the findings of the present series and those of previous articles appears to be a direct reflection of the remarkable advances made in the diagnosis and treatment of brain tumors during the past several decades. The reports cited above all appeared prior to the period covered by the cases herein reported. With the diagnostic aids of electroencephalography, ventriculography, and arteriography, fewer cases of intracranial tumor are now allowed to progress to the stage where papilledema becomes visible to the ophthalmoscope.

The higher percentage (75.2 percent) in the present report for tumors arising in the posterior fossa of the skull is much nearer to comparable figures in the literature. The papers of Critchley,[1] of Newman,[5] and of others report a high incidence of papilledema for tumors of the brain in children. It is true that the greater percentage of brain tumors in childhood are of the subtentorial variety. This closer correlation of reports for papilledema between subtentorial tumors for different age groups appears to reflect the earlier and more severe interference with the circulation of the cerebrospinal fluid with resulting internal hydrocephalus.

The preponderance of bilateral papilledema in this series serves to verify the statement of Duke-Elder,[3] who writes that in the great majority of cases the degree of edema is equal in the two eyes and that a greater amount of swelling in one optic nervehead is not of lateralizing value.

As would be expected, the majority of the cases of primary optic atrophy occurred where the direct action of the tumor was exerted upon the optic nerve, the optic chiasm, or the optic tract. At least 13 out of the 17 instances of such atrophy could be so classified if one were to include the frontal, frontoparietal, optic chiasm and nerve, sphenoidal wing meningioma, and pituitary groups. All of the tumors so listed are also much less likely to produce papilledema until very late in their course. Nineteen of the 25 instances of secondary optic atrophy occurred in cases in which the ventricular system could be easily involved, and thus papilledema occurs early to be followed by a post-papilledema type of atrophic change. The small number of cases evidencing the Foster Kennedy syndrome should be mentioned. None occurred in purely frontal lobe lesions, but two instances were found in more extensive tumor involvements classified as frontoparietal. The third case was found with a sphenoidal wing meningioma. The fourth instance was equivocal and occurred in a case with a tumor of the lateral ventricle.

It will be seen from Table 3 that the most frequent visual field findings were homonymous hemianopia and peripheral constriction. There were 35 instances of homonymous hemianopia in the 231 examinations performed, or slightly over 15 percent. As would be expected on anatomic grounds, the majority of such findings occurred in cases with involvement of the cerebral hemispheres. Although recorded in too few cases to be of great significance, the relative occurrence of macular sparing as compared with macular splitting should be mentioned. There is certainly no indication in the table to support the classic view that macular splitting is more apt to occur with involvement of the optic tract.

On the other hand, the finding of sparing of the macula exclusively in the tumors of the hemispheres may have some relative value. It will be noted that the majority of such cases are recorded for locations where the optic radiations could be involved. Therefore it would be logical to assume that the fixation reflex pathways, the corticotectal tracts[2] which lie just outside the radiations, would also be involved. This would lend support to the view of Verhoeff,[9] who believes that sparing of the macula may be the result of faulty fixation.

The finding of quadrantanopia is not indicative of temporal lobe involvement in this series of cases. A study of the table appears to support the view of Walsh,[10] who states,

"An homonymous quadrant defect in the visual fields suggests involvement of the dorsal or ventral band respectively in the optic radiation, and such an involvement may be in the temporal lobe." There was only one case in this series in which quadrantanopia occurred in a proved temporal lobe tumor. On the other hand, there were nine of the group which showed a homonymous hemianopia.

Mention should be made of the specificity of the finding of bitemporal hemianopia in localizing tumors to the chiasmal region. This can be verified from Table 3. It is important to note that not one single instance of bitemporal hemianopia was recorded which could logically be due to dilatation of the third ventricle, although 54 patients with subtentorial tumors were examined by perimetric methods.

There were 56 cases in which either hemianopia or quadrantanopia occurred. Thus, field findings of localizing value were present in slightly over 25 percent of the cases in which a perimetric examination was performed. The value of examining the fields of vision in any case suspected of harboring a brain tumor therefore should be evident.

The finding of anisocoria in a case of suspected brain tumor is said to have little localizing value, according to Walsh.[10] That inequality of the pupils with irritative cortical phenomena can occur has been borne out by Penfield and Erickson.[7] However, certain of the cases listed in the table could well have been unrecognized instances of Horner's syndrome. It will be noted that in the frontal, temporal, and temporoparietal tumors, the larger pupil was most often to the side of the tumor, but the number of cases is too small to warrant any definite conclusions.

The small total number of conjugate palsies (5.6 percent of the series) indicates how infrequently such a finding occurs. The greater number of upward gaze palsies in tumors of the pineal gland shows a distinct localizing value. Downward pressure exerted by a pinealoma affects the more superficial tectal layers of the midbrain early. It has been shown experimentally that the corticotectal fibers which reach the roof of the midbrain are those having to do with vertical movement.[4] It is anatomically difficult to explain the upward gaze palsies noted for the two cases of frontal lobe tumor presented in Table 5.

Nystagmus is said to be present in a great majority of cases with cerebellar tumor.[10] This statement is substantiated by the present series, where 20 of 58 cases showed this finding, an incidence of 34.5 percent. As stated earlier in this paper, the lack of uniform classification in the records studied makes further conclusions valueless except to reiterate that the motor connections for ocular movements were probably involved in most of the other cases. The total of 39 cases in which nystagmus was recorded gives an incidence of 10.9 percent.

The much greater incidence of abducens nerve involvement in the cases studied confirms the fact that the sixth cranial nerve is relatively less protected in its long intracranial course. An increase in intracranial pressure alone may be enough to implicate this nerve by shifting the position of the brain stem. There is little localizing value from abducens palsy, as may be seen in Table 6. A review of the records shows further that the lateralization of the palsy has no significant bearing on determining the side of the tumor. The lesser number of oculomotor and trochlear palsies would indicate either a shorter intracranial course or a more protected position. It will be noted that such ocular palsies occurred in only 13.4 percent of the total series. The convergence palsies noted in the table are difficult to accept unless one assumes that these may have been unrecognized cases of internuclear ophthalmoplegia.

Summary and conclusions

In a series of 358 cases of intracranial tumor the following ocular findings were present:

1. The incidence of papilledema was 59.5 percent. Tumors which were above the tentorium presented papilledema in 53.3 percent of the cases, while the subtentorial group had a 75.2 percent incidence. Almost all the cases were bilateral.

2. Optic atrophy was found in 12 percent. The cases with primary optic atrophy were mainly those in which direct involvement of the nerve, chiasm or tract was possible. Those with secondary atrophy occurred where the tumor could produce an early rise in intracranial pressure.

3. Abnormal findings were present in slightly less than half the cases where the visual fields were examined. The findings were of localizing type in slightly more than 25 percent of the cases tested.

4. The statement of Walsh[10] that pupillary changes are of little localizing value was supported by the present study. Anisocoria occurred in 12 percent of the series.

5. Defects of conjugate movement occurred in 5.6 percent of the cases. Involvement of upward conjugate gaze in pineal tumors appeared to have the greater value for localization.

6. Nystagmus was present in 10.9 percent of the series. It was a frequent finding in cases of tumor of the cerebellum.

7. Extraocular muscle palsies were found in 13.4 percent of the cases. The incidence of abducens, oculomotor and trochlear involvement reflects their anatomic arrangement. Such palsies were of little value in lateralization.

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THE DYNAMICS OF PHAKOERISIS*

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The simplification of instruments for intracapsular cataract extraction by the suction method has increased the popularity of the procedure which Barraquer called "phakoerisis," and has reduced its hazards to such an extent that it may now be considered a safe method of cataract extraction in average hands.

It is important, therefore, to know the manner in which the erisophake accomplishes the rupture or peeling of the zonular lamella from the lens and, after dislocation of the lens, allows its intracapsular extraction.

In a previous publication[1] concerned with "The mechanics of intracapsular cataract extraction" by the method of external pressure and forceps traction, I stated that "the mechanism of action of the erisophake is based on an entirely different basic principle and is deserving of a special study already begun."

Studies on animal and cadaver eyes and careful analysis by highly magnified slow motion pictures of erisophake extractions on living human eyes, plus microscopic and photographic studies on extracted lenses, have demonstrated a dynamic principle in phakoerisis which is wholly dissimilar from the mechanics of zonular rupture, lens dislocation, and intracapsular lens extraction by the method of combined external pressure and forceps traction.

The modern sucking disk exerts a safe, self-controlled, powerful, and evenly distributed pull on the anterior lens capsule and through it on the zonular lamella which is highly tensed and actually drawn forward onto the anterior lens surface toward the cup of the instrument.

Once the anterior lens capsule is firmly fixed in the grasp of the cup, one of several maneuvers, depending on the type of cataract, will peel the zonular lamella from the equator of the lens which may then be tumbled or slid from the hyaloid fossa without disturbance of the vitreous.

The vitreous is not utilized in the zonular rupture, lens dislocation, and tumbling as it must be in the method of external pressure and forceps traction (fig. 1). In those erisophake extractions where external pressure is required, such as in young eyes with resistant zonular lamella, or where too small corneal section has been made, it is applied directly to the lens through the cornea and in minimum degree, primarily as a means of assisting the passage of the lens through the wound.

Capsular traction by forceps, equal in amount to that exerted by an erisophake, would almost certainly rupture the capsule at the point of application of the forceps, due to the uneven distribution of the lines of force on the capsule. The point of greatest capsular stress in an erisophake extraction is at the posterior pole of the lens rather than at the point of application of the suction cup. It is this drawing forward of the lens capsule around the equator of the lens with the consequent stretching of the zonular lamella and the distortion of its equatorial lens attachment that gives the main clue to the dynamics of phakoerisis (fig. 2).

HISTORY AND INSTRUMENTS

There is a considerable bibliography on the suction method of intracapsular cataract extraction. Aside from a few authors whose contributions were fundamental and

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Photographs by Rafael and Newman; drawings by Kay Hyde, U.S. Veterans Administration Hospital, San Francisco, California.

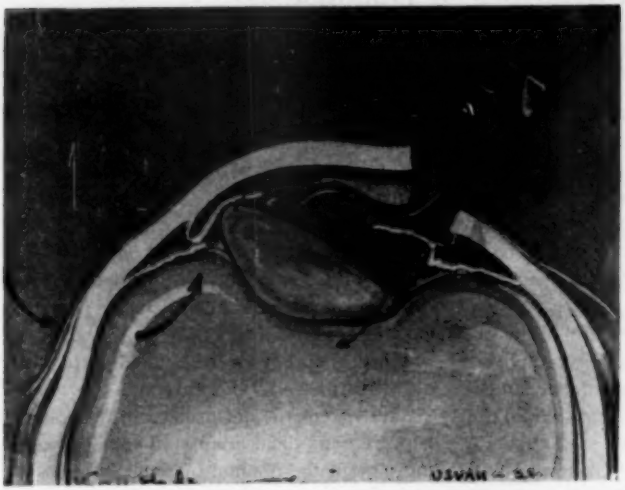

Fig. 1 (Harrington). Extraction by method of external pressure and forceps traction, showing utilization of vitreous wedge in zonular rupture.

far reaching in advancing the method, the majority of articles deal with experiences and case reports.

The first successful use of a sucking disk for intracapsular lens extraction was reported by Stoewer[2] in 1902. The idea of buccal suction had apparently been suggested even before this. Stoewer, using a tiny spoon-shaped disk attached to a rubber bulb, performed two successful intracapsular cataract extractions on human eyes.

Hulen[3] in 1910 described his method of creating a powerful vacuum in a large demijohn from which the air was exhausted with a pump operated by a nurse. The sucking disk for fixating the lens was attached to this demijohn by a long rubber tube and vacuum control was completely out of the operator's hands. Nevertheless, six successful intracapsular cataract extractions were reported, and it was agreed that, if a less cumbersome instrument could be devised, a new and ideal method of lens extraction would be available. Hulen considered his disk as only another method of fixating the lens, which was "elevated and rotated to sever the suspensory ligament" and then delivered head first.

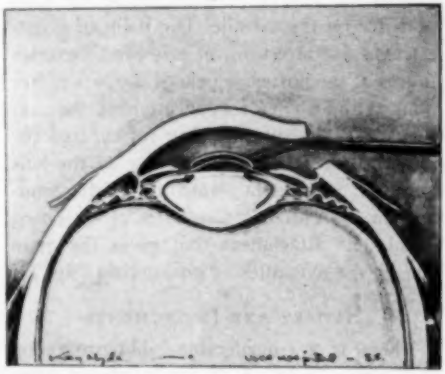

Fig. 2 (Harrington). Distortion of Lens capsule by suction. Lines of direction of capsular and zonular tension.

In 1916, Barraquer[4] described the method of suction extraction which he called "phakoerisis," using a motor-driven vacuum pump connected directly to his erisophake by a rubber tube. Credit for the zonular rupture was given to the vibrating effect of the rapidly interrupted vacuum and, in fact, the instrument was called a "vibrating zonulatome."

While Barraquer's results with this instrument were remarkable, they were not duplicated by many surgeons who encountered rather disastrous complications and largely abandoned the procedure. The average ophthalmic surgeon was frankly afraid of the degree of suction employed and his failure to control the vacuum perfectly.

When, in 1939, Dimitry[5] evolved a new and simplified sucking-disk instrument, its advantages were immediately apparent. It

was simple in construction, self-contained, and its vacuum self-controlled. Perhaps Dimitry's greatest contribution was his demonstration that the "only vacuum required to provoke a grasp in a sucking disk is that measured in the bore of the needle and the concavity of the cup." The powerful vacuums of Hulen and Barraquer with their hazards to vitreous and iris were unnecessary.

Even this simple instrument, however, was too cumbersome for most surgeons. Its use required an uncomfortable and unaccustomed hand position both for its application to the lens capsule and the subsequent manipulation of lens extraction.

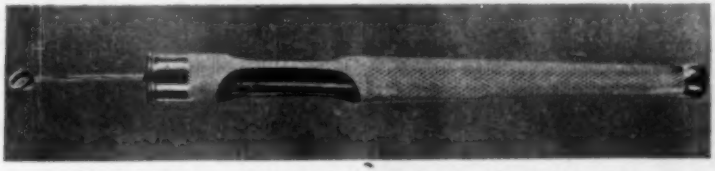

Fig. 3 (Harrington). Simplified erisophake. Assembled instrument.

Attempts were made to modify the instrument to avoid this clumsiness while still retaining the valuable basic principle. Thomas,[6] for example, attached a suction tip to a small, easily manipulated handle which was fastened by a short rubber tube to a modified Dimitry syringe. The vacuum was controlled by an assistant and the instrument increased the ease of handling of the lens at the expense of loss of vacuum control by the surgeon.

Bell[7] in 1948 devised the ultimate in simplicity in an erisophake when he fastened a small rubber contact glass sucker to a Dimitry tip, thus, in effect, reverting to the original erisophake of Stoewer. This small rubber bulb, squeezed between thumb and forefinger, provides adequate vacuum to attach the sucking cup strongly to the anterior lens capsule. The instrument is small enough to be easily handled by the surgeon without the need of assistance in the creation of the vacuum.

Even the Bell erisophake has certain disadvantages. With only the support of the rubber ball, the needle may wobble when introduced into the anterior chamber and applied to the anterior surface of the lens. After suction is applied and lens extraction begun, the manipulation of the tip is controlled through the rubber bulb used as a handle. Even the slightest pressure on the bulb will introduce air into the vacuum cup and its hold will be lost. The bulb and needle together are so short that one does not have the accustomed "feel" of an instrument in the hand and precise control of rotation of the lens in the tumbling method of extraction is difficult and somewhat clumsy.

It occurred to me that, if the principle of the Bell erisophake could be incorporated in an instrument with a solid handle rigidly fastened to the needle holding the suction cup, these disadvantages might be largely eliminated. I have designed and used such an erisophake[8] with much satisfaction (fig. 3).

Once the vacuum cup has grasped the lens capsule, the bulb is released and further manipulation of the instrument in the extraction of the lens is through the rigid and easily controlled metal handle. The effect is essentially that of a cross-action forceps, in that further pressure with the fingers need not be applied, thus allowing for greater delicacy of touch in the manipulation of the lens.

The vacuum developed is limited to that within the rubber bulb, and although sufficient to grasp the capsule firmly will not, if misapplied, injure the iris or even suck up exposed vitreous, as can be demonstrated after lens extraction in a cadaver eye. Furthermore, the vacuum is self-controlled so

that in the event of slippage from the capsule no harm can result and the suction cup is simply reapplied to the lens and the extraction continued.

The perforated suction tip of Veirs,[9] designed to minimize capsular rupture when used with a motor-produced vacuum, is an excellent instrument for lens fixation but does not produce the capsular distortion so important for zonular rupture and so is not relevant to this discussion.

Indications for use of erisophake

Generally speaking, all types of cataract may be extracted intracapsularly by the suction method.

The most notable exception to this statement is the dislocated lens in which the vitreous has presented into the anterior chamber ahead of the lens. Even in these cases phakoerisis may be safely tried but, unless the suction cup can be applied directly to the capsule without pressure, the intervening vitreous will not allow a grasp of the capsule, and a forceps or loop extraction must be performed. The caliber of the needle is so small and the strength of vacuum so mild that there is little or no danger of aspiration of vitreous in these cases unless the vitreous is very fluid, a situation that is easily ascertained at the time of operation.

In fully mature cataracts with large sclerotic nucleus the anterior lens capsule, while easily grasped, does not mold as readily into the suction cup as in the soft cataract. The zonular lamella is not, therefore, drawn forward as far onto the anterior lens surface and is less tensed by the traction of the vacuum. It is advisable in these cases to apply slightly more external pressure over the inferior lens equator or even to utilize the vitreous as a hydrostatic wedge, as in the method of forceps extraction, in order to peel the zonular lamella from the lens. Fortunately in the majority of these cases the zonule is very weak and readily ruptured.

In the average immature cataract with a small or soft nucleus, the capsule molds forward into the suction cup; the equator of the lens is drawn forward and the zonular lamella is tautened and peeled from the capsule by traction alone. The lens may then be readily tumbled, molded through a round pupil and extracted by slow traction. External pressure is seldom required unless it be to assist the lens in its passage through the corneal section.

Eyes with an intumescent or hypermature lens are perhaps the ideal cases for erisophake extraction, for the operation may be successfully performed by this method in the majority of instances and infrequently by the use of intracapsular forceps. In these cataracts the capsule is usually extremely tight, slippery, and fragile, so that either it cannot be grasped by forceps, or if it is grasped is notoriously prone to tear. For these reasons they are eminently suitable for erisophake extraction. Because they are so easily molded a minimum of vacuum is required. The wide distribution of traction lines on the fragile capsule minimizes the danger of its tearing.

Thomas[6] has already pointed out the desirability of the method in cases with exfoliation of the lens capsule.

Application of suction

As has already been pointed out, the effect of suction on the anterior lens capsule varies with the type of cataract. For this reason, when using the rubber bulb erisophake, the degree of vacuum should be varied somewhat, depending on the case. The bulb should be filled with saline and, before the suction cup is introduced into the anterior chamber, a greater or less amount of this fluid is expressed, depending on the degree of vacuum desired. Variations in vacuum are small but they may be significant and important with swollen lens or friable capsule.

If hyaluronidase is used in the retrobulbar anesthesia, as advocated by Atkinson,[10] the globe is often very soft. External pressure will lift the lens through vitreous tension so that the suction cup may be readily and lightly applied.

The cup is introduced into the anterior chamber through the temporal third of the wound and applied slightly below the center of the lens if the lens is to be tumbled, or slightly above its center if the lens is to be delivered head first. If the pupil has contracted somewhat during the corneal section or iridotomy maneuver, the cup may be easily slid beneath the iris border or a three mm. cup may be used.

When suction on the capsule has been established it is well to wait for 10 to 15 seconds before starting the maneuver leading to zonular rupture and lens dislocation and extraction. This allows the capsule to be more firmly fixed in the cup and consequently drawn forward its maximum amount, resulting in increase in zonular tension.

Zonular rupture and lens dislocation

In mature cataracts with sclerotic nuclei, it may be advisable or necessary to combine external pressure with capsular traction to accomplish the rupture of the zonular lamella and later to assist in the tumbling and delivery of the lens. Because the lens is less elastic and its shape will not be greatly altered by molding, the suction cup acts primarily as a fixating instrument which controls the rotation and delivery of the lens rather than as a zonulatome. Because its traction is gentle and evenly distributed over the capsular surface, and because the zonular lamella in these cataracts is weak, a minimum amount of manipulation is required to accomplish the peeling of the zonule from the lens equator.

In the majority of instances the lens may be tilted in the hyaloid fossa by a gentle rocking motion of the erisophake handle and no pressure is required to effect zonular rupture. When this does not suffice, a slow and gentle massage of the upward tilted inferior equator of the lens through the lower corneal limbus is all that is necessary to effect the separation of the zonule from the lens, after which a further rotation or tumbling of

Fig. 4 (Harrington). Capsular distortion showing forward movement of equatorial portion

the lens with the erisophake frees it from the hyaloid fossa.

Delivery of these lenses through the wound should be assisted by external pressure, tucking the cornea behind the lens in its upward movement through the incision in much the same manner as in the end stage of the original Smith-Indian[11] operation. Rarely is it necessary to apply external pressure in such a way as to increase vitreous tension or to utilize the hydrostatic action of the vitreous in the dislocation or delivery of the lens.

Immature cataracts of soft consistency and with soft or small nuclei are freed from their zonular attachment in quite a different manner.

Observations of the anterior lens capsule under magnification at the moment of application of the suction cup demonstrate that it is drawn forward by the vacuum which exerts its traction equally in all radii.

The equatorial portion of the capsule with

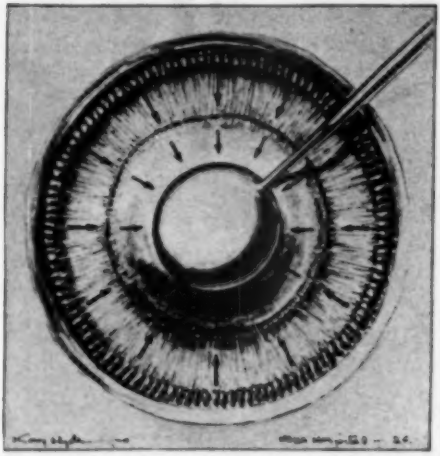

Fig. 5 (Harrington). Demonstration of lines of force on capsule and zonule produced by vacuum cup.

its zonular attachment is thus drawn forward onto the anterior lens surface (fig. 4). The zonule is so tensed and displaced tangentially to its original direction of pull that the slightest movement of the lens within the grasp of the erisophake "shears" the zonular lamella from the lens equator.

Thus the erisophake acts on these lenses not only in fixation of the lens for manipulation and delivery, but also in part as a "zonulatome," although vibratory action, as suggested by Barraquer,[4] is unnecessary.

This forward displacement of the anterior and equatorial capsule and the zonular lamella in soft lenses was demonstrated dramatically in the cadaver eye when cornea and iris were removed exposing the lens and its zonular attachment. Lampblack was finely dusted over the lens and zonular surface and when the suction cup was applied the black particles were seen to move toward the cup (fig. 5).

Microscopic study of extracted lenses, which were left attached to the erisophake and allowed to dry slightly, graphically demonstrated this phenomenon and showed especially well the forward displacement of the equatorial capsule of the lens (fig. 6).

Still further proof is found in the manner and mechanism of capsular rupture in phakoerisis, which will be discussed later.

In the erisophake extraction of intumescent and hypermature cataracts the extreme malleability of the lens provides for an exaggeration of the effects already discussed. As pointed out by Thomas,[8] these cataracts are ideal for phakoerisis. Because the capsule is either very friable or tight, or both, it is grasped with great difficulty if at all by forceps, and if grasped will usually tear. Zonular rupture must be accomplished almost entirely by external pressure when capsule forceps are used. In consequence most cataracts of this type have in the past been extracted by the extracapsular method.

When the erisophake is applied to these lenses, care must be taken to use only a portion of the vacuum which may be produced with the small rubber bulb. Even with minimum suction, the capsule is drawn sharply into the cup; the capsule is displaced forward a maximum amount and frequently at

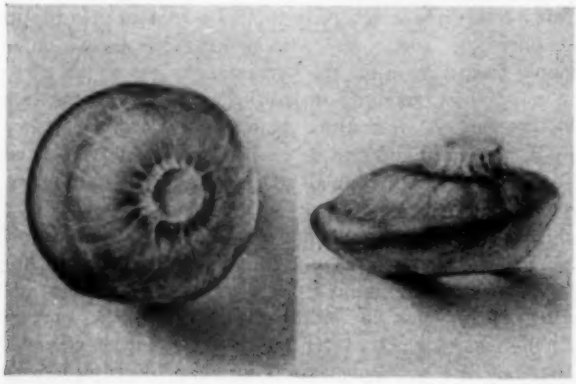

Fig. 6 (Harrington). Lens allowed to dry while attached to erisophake. Demonstration of anterior displacement of equatorial portion of capsule.

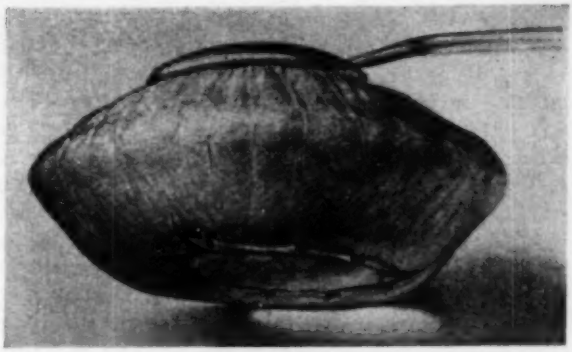

Fig. 7 (Harrington). Mechanism and location of capsular rupture in phakoerisis.

the instant of application of suction the zonular lamella is separated from the lens which is dislocated and comes forward toward the wound. One cannot be said to tumble these lenses for they mold and elongate in such a way that they must be literally dragged through the incision.

It is at this point in delivery, when the lens is one half to two thirds out of the globe, that capsular rupture is most apt to occur. For this reason the inside diameter of the corneal section must be large and final delivery of the lens must be assisted by external corneal pressure. In the majority of cases intracapsular extraction is accomplished with the erisophake.

As in all types of intracapsular cataract extraction, the suction method must proceed slowly to avoid disturbance of the vitreous and sudden changes in the hydrodynamics within the eye. A short interval after application of the suction cup will fix its grasp more firmly and will allow for maximum capsular displacement. A slow rocking motion of the lens will usually be all that is required to rupture the zonule. Too rapid withdrawal of the lens may distort or even rupture the hyaloid and must be avoided if possible.

Capsule rupture

In a report of the results of 1,000 cataract extractions by the suction method, Barraquer[12] had only four instances of broken capsule. Thomas[6] reported 75 suction extractions with no ruptured capsules.

I have ruptured one capsule by accident and one by intention with the erisophake. In both cases, the cup was applied dry and maximum vacuum obtained by complete evacuation of a rubber bulb which was stiffer than usual. In both instances, the capsule split on the posterior lens surface and not at the point of suction application, and, remaining attached to the erisophake, was peeled from the lens and removed from the eye. The remaining lens cortex and nucleus was expressed from the eye. The result was a modified intracapsular extraction.

Reapplication of suction to lenses which have been extracted shows that the point of greatest tension in the capsule is at the posterior pole of the lens. If the lens capsule is inspected with the binocular microscope, it is seen to be stretched taut at this point, due to the anterior movement of the equatorial portion of the capsule. Increase of the vacuum stretches the posterior capsule until it finally splits (fig. 7). Because of the small bore of the needle, the capsule will not be sucked up into the erisophake. It remains firmly attached to the cup and is stripped from the lens.

If the posterior capsule is not split by vacuum action alone, it may break if an attempt is made to draw a swollen lens through a too small corneal section. A much more common occurrence is the slippage of the suction cup from the lens surface with the necessity of reapplying the cup. This is easily done and the extraction completed without further mishap. On occasion, the lens may slip from the suction cup several times if attempts are made to draw it by traction alone through a small incision.

Corneal section must be large and it

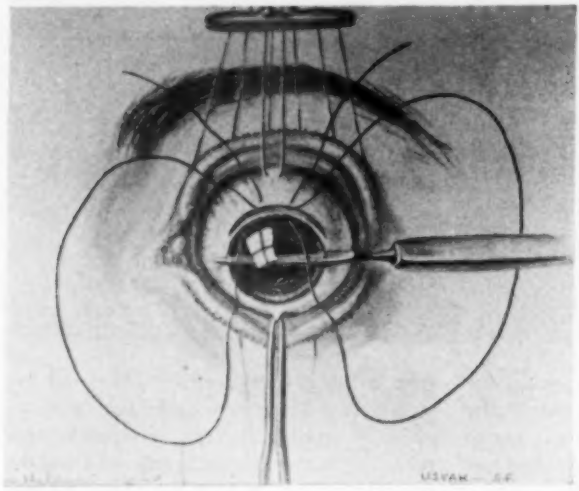

Fig. 8 (Harrington). Size of corneal section. Corneoscleral suture and conjunctival flap.

should be emphasized that it is the inside diameter of the incision that is important (fig. 8). This is particularly true when section is made by keratome and scissors, as these wounds have a greater bevel than those made with a Graefe knife.

On two occasions I have been able to perform an intracapsular cataract extraction with the erisophake after the capsule had been ruptured on its anterior surface by capsule forceps. The suction cup was applied over the capsular rent and the lens dislocated and tumbled as though intact.

Summary and conclusions

The increasing popularity of phakoerisis as a method of intracapsular cataract extraction makes it important to understand the dynamics of the procedure. The modern erisophake with its limited, self-controlled vacuum has eliminated the hazards of the method of Barraquer and converted it into a method which is safe in average hands.

Studies on animal and cadaver eyes and analysis and study of erisophake extractions on living human eyes and of cataractous lenses after removal, have demonstrated the following facts:

1. Application of suction to the anterior lens capsule draws the capsule forward into the suction cup.

2. The lines of traction on the capsule are evenly and uniformly distributed.

3. The lines of capsular stress are transmitted to the equatorial region which is pulled forward onto the anterior lens surface.

4. The zonular lamella is made taut and drawn radially inward and forward so that almost its entire attachment becomes tangential to the lens equator.

5. The distortion of the zonular lamella causes it to strip or peel easily from its capsular attachment without trauma to either the lens, vitreous or ciliary body.

6. Little or no external pressure is required to accomplish this rupture, and no distortion of the vitreous is needed as in the method of combined external pressure and forceps traction.

7. The degree of vacuum required, and the manipulation, dislocation, and delivery of the lens, may be varied slightly depending upon the type of cataract encountered.

8. Capsular rupture is rare, and when it occurs takes place at the posterior pole of the lens so that the entire capsule is stripped from the lens and withdrawn from the eye.

9. The procedure is applicable to all types of cataract including the dislocated lens, except when viscid vitreous is encountered in the anterior chamber in front of the lens.

10. In the event of misapplication of the suction cup the only mishap which can occur is the slipping of the lens from the vacuum. The cup may then be reapplied with ease, even though a complete dislocation of the lens has occurred. This is the only method of intracapsular cataract extraction

where it may be said that mistakes can be readily rectified without prejudice to the final result. Capsule forceps do not slip from the lens; they tear the capsule and may not be reapplied. The erisophake may be applied to the lens over these tears and successful intracapsular extraction accomplished.

As in all forms of intraocular surgery some practice is required to master a new technique whose principles are dynamically different from those in common use. Certain manipulations may have to be "unlearned" before unaccustomed surgical maneuvers are accomplished with confidence and certainty. It is worthy of note that beginners in ophthalmic surgery become quickly adept in the modern methods of phakoerisis and, having developed confidence in the safety of the procedure, tend to prefer it to all other methods of cataract extraction.

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THE EFFECT OF ANTICOAGULANTS ON THE CLOTTING IN THE PLASMOID FLUID AND ITS SIGNIFICANCE FOR THE INTRAOCULAR PRESSURE*

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One of the most dangerous complications of chronic iridocyclitis is the protracted high intraocular pressure which resists nearly every kind of treatment. This form of secondary glaucoma is most probably caused mainly by a blockage of the excretory channels by peripheral synechias or particles in the "plasmoid fluid" consisting, for instance, of fibrin.

The widespread use of such anticoagulants as dicumarol and its derivates makes it a rather obvious procedure to examine, first of all in animals, whether there is a possibility of preventing in vivo the coagulation of the aqueous fluid containing fibrinogen and the subsequent secondary increase in tension.

The present paper deals with an investigation concerning the influence of a treatment with Tromexan on the clotting time and the prothrombin time of the plasmoid fluid excreted after emptying the anterior

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chamber of rabbits. In addition, parallel examinations have been made of the effect arising from this treatment upon the secondary glaucoma which follows the puncture of the anterior chamber of these animals.

Tromexan is an ethyl ester of the di-(4-hydroxycumarinyl-3) acetic acid. It lowers, like dicumarol, the level of prothrombin

Methods

The investigation was carried out on 10 rabbits (weight 1.8 to 2.2 Kg.) of both sexes. The anterior chamber was punctured so as to remove aqueous fluid for the examination of the clotting time (first aqueous fluid). It was possible to repeat the puncture after one hour because, after this time, the

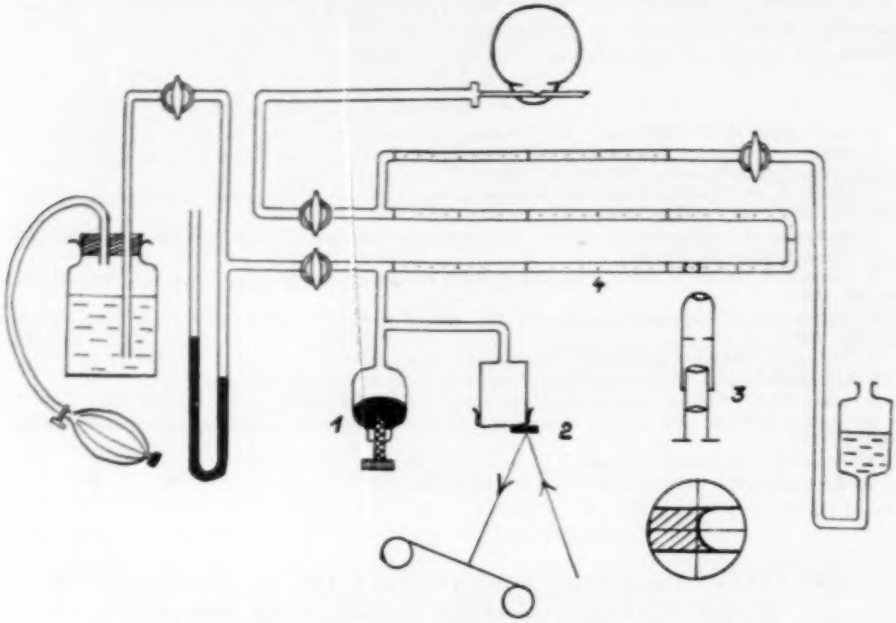

Fig. 1 (Zwiauer, Bornschein, and Deutsch). Device for continuous registration of the intraocular pressure. (1) Screw-compensator. (2) Optical manometer system. (3) Microscope for observation of an air bubble serving as indicator. (4) Graduated capillary tubes for measuring the outflow.

and only slightly influences the factor V (Deutsch[1]). It differs from dicumarol in that the effect appears much earlier, does not last so long, and ceases much more rapidly after the medication is ended. In spite of this it is easy to obtain a constant lowering of the prothrombin level.

These properties render it easier to control the effect, and the treatment becomes less dangerous. Furthermore, the effect upon the fragility of the capillaries is less than with dicumarol thereby lessening the tendency to hemorrhage.

anterior chamber was completely restored (plasmoid fluid).

One week after the first two punctures, the medication with Tromexan (150 mg./Kg., approximately daily for four days) was begun and the level of prothrombin was lowered to 20 percent. Under the same conditions as in the untreated rabbits the first and the second aqueous fluid were taken.

The time of spontaneous clotting and the prothrombin time was measured in all four samples. It may be stressed that the clotting time, as well as the prothrombin time, was

reckoned from the beginning of the puncture, but it was only possible to add the thromboplastin to the fluid 15 seconds after the puncture; therefore, the values of prothrombin time are somewhat too high.

The registration of the intraocular pressure was carried out with the help of an optical manometer applying the compensation principle. The principle of the device used is shown in Figure 1.

Its advantage is that it is possible to change the actual intraocular pressure by the inflow or outflow of a known volume of Ringer's solution without interrupting the registration. It is also possible to observe the subsequent reaction of the eye. Furthermore, it is possible, by maintaining artificially a constant intraocular pressure, to measure the volume of the outflowing aqueous.

The registration of the pressure was always carried out on the right eye of the rabbit after a medication with Tromexan, the animal being under a light narcosis (Urethane, 0.8 gm./Kg.).

The intraocular pressure was lowered to zero by the outflow of the necessary volume of aqueous. The spontaneous rise of the intraocular pressure after the emptying of the anterior chamber was registered. In the evaluation of the curves gained by this registration, the height of the peak and the time necessary to rise to this height were taken into consideration.

Since it was necessary to consider the possibility of an infection after the registration of the pressure, care was taken to avoid the registration previous to the medication with Tromexan. It was, therefore, necessary to compare the results of a parallel examination of 10 control rabbits without previous medication with Tromexan.

Results

The first aqueous was absolutely clear, both in the treated and untreated animals. It was easy to obtain a volume of 0.15 to 0.20 ml., and no coagulation, either spontaneous or as a result of the addition of thromboplastin or thromboplastin and fibrinogen, was observed. Therefore, the conclusion may be drawn that the normal aqueous does not contain prothrombin.

A lenticular exudation, consisting of fibrin, developed in the eyes of the untreated rabbits as a result of the puncture. It was difficult, therefore, to extract plasmoid fluid because the needle of the syringe was blocked by fibrin. In four cases it was impossible to obtain a sample. In the other six cases a clotting time of 95 ± 16 seconds and a prothrombin time of 42 ± 9 seconds, were measured.

The anterior chamber of the rabbits treated with Tromexan remained in all cases entirely clear, did not contain fibrin, and it was easily possible to extract 0.20 ml. of plasmoid fluid. The clotting time of these samples was 260 ± 130 seconds; the prothrombin time, 104 ± 64 seconds.

It was possible to prove statistically the observed prolongation of the clotting time and prothrombin time ($P < 0.01$). This is the more noteworthy as the plasmoid fluid of the untreated rabbits clotted partly in the eye itself before the puncture. Therefore, the samples of this fluid undoubtedly contained substantially less fibrin than the samples taken from the rabbits treated with Tromexan.

The registration of the intraocular pressure showed that the tension in the case of the untreated control rabbits, after a short reduction to zero, rose spontaneously to 57 ± 9 mm. Hg, and this peak was reached within 10 ± 3 minutes. In the case of the 10 rabbits treated with Tromexan the tension rose only to 25 ± 13 mm. Hg, and the peak was reached in 11 ± 3 minutes. The difference in the average values of the peaks of the two groups is highly significant ($P < 0.001$), but it is impossible to demonstrate a difference in the periods of time necessary to reach these peaks ($P > 0.05$). A typical curve of the two groups is shown in Figure 2.

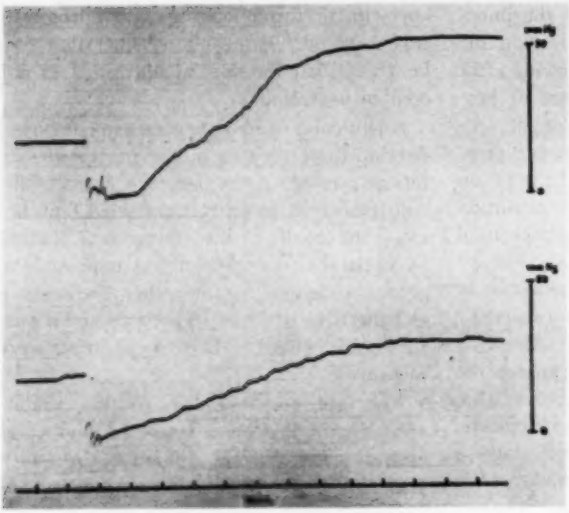

Fig. 2 (Zwiauer, Bornschein, and Deutsch). Registration of the intraocular pressure, showing spontaneous rise after emptying of the anterior chamber. (Above) Untreated animal. (Below) Animal treated with Tromexan.

The intraocular pressure of four more rabbits was measured after emptying the anterior chamber under the influence of heparin so as to determine whether the prevention of the secondary glaucoma previously described was to be attributed to a specific quality of the anticoagulant applied or could be observed in all cases in which remedies with a similar effect were applied.

The cannula used in these experiments was filled with a solution of heparin and, at the beginning of the experiment, 0.02 ml. of this solution was injected into the anterior chamber. The spontaneous rise of the intraocular pressure in these cases, after the emptying of the anterior chamber, was 35 ± 9 mm. Hg; the time necessary to reach the peak was 10 ± 2 minutes. Despite the small number of experiments, the increase of tension was significantly lower by comparison with the central group ($P < 0.01$), but it was impossible to determine any significant difference by comparison with the group treated with Tromexan ($P > 0.05$).

Discussion

These experiments prove that the well-known marked increase of the intraocular pressure in animals, especially in rabbits, after the emptying of the anterior chamber is mainly due to a blocking of the outflow; that the increase in tension reaches the level of the normal intraocular pressure only if clotting of the plasmoid fluid has been prevented intra vitam by Tromexan; and that this secondary tension increase may be averted.

These results may be of certain clinical value. The investigation will be continued to determine whether it may be possible to use anticoagulants to prevent secondary glaucoma due to the formation of synechias in the anterior half of the globe. This possibility was theoretically suggested by Bick.[2]

Summary

This investigation has shown that there is no clotting in the plasmoid fluid of the anterior chamber after treatment with anticoagulants and, furthermore, that there is a significant prolongation of the clotting time and prothrombin time in comparison with the corresponding values of the plasmoid fluid of untreated rabbits. The intraocular pressure after emptying the anterior chamber of rabbits treated with Tromexan rises only to the physiologic value, so there is no secondary increase as in untreated animals.

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REFRACTIVE AND OCULAR FINDINGS IN THE NEWBORN*

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The incidence of refractive errors has stimulated so much interest that a number of statistical analyses are available, but most of these studies have been on young children and adults. Consequently, data on the refractive errors in the newborn, particularly in this country, are scarce. We have, therefore, assumed that most children are born hyperopic.

deSchweinitz[1] states that hyperopia is nearly always congenital but myopia is seldom so. Ball[2] makes similar statements. Fuchs[3] says that nearly all infants' eyes are hyperopic (but rarely exceeding four diopters) and that myopia is only exceptionally congenital. Berens[4] declares that the majority of eyes are hyperopic at birth and that myopia develops later. Fox[5] agrees with the others in the statement that hyperopia is nearly always a congenital defect and that most children are born farsighted.

Duke-Elder[6] concludes that simple hypermetropia is the normal optical condition in infants and persists throughout life in 50 percent of the population of the world. Regarding myopia, Duke-Elder[7] implies that it occurs congenitally; but in the majority of cases, it first appears between the ages of five and puberty.

In 1861, Professor von Jaeger[8] examined 100 eyes in 50 infants between the ninth and 16th day of life without the use of cycloplegics. He reported finding emmetropia in five percent of the cases, myopia in 78 percent, and hyperopia in only 17 percent.

Ely[9] made a study of 100 eyes within the first seven days of life, estimating the refractive error with the ophthalmoscope only. Preparation of his cases consisted of one drop of 0.5-percent atropine sulfate solution instilled in each eye and a small dose of paregoric by mouth. His own accommodation was paralyzed by instilling 0.5-percent atropine solution in his eyes before the examination. He derived the following findings: Emmetropia, 17 percent; myopia, 11 percent; hyperopia, 72 percent.

In 1892, Herrnheisser[10] examined 1,918 eyes of newborn infants between the ages of eight and 14 days. He found the average refractive error to be 2.32D. of hyperopia.

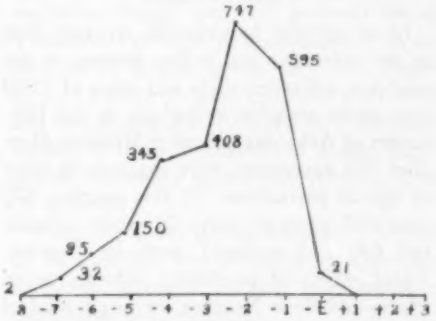

Fig. 1 (Cook and Glasscock). The distribution of refractive errors estimated under atropine cycloplegia in a composite series of newborn infants. Negative values = hypermetropia; positive values = myopia in diopters. (After Wibaut.[11])

Wibaut[11] made a very extensive study of a composite series of refractive findings in 2,398 newborn infants examined by several ophthalmologists. Unfortunately the findings did not agree very well, probably due to the difficulty of the undertaking and to the heterogeneity of the materials and the investigators. From this study, the curve of refraction of the newborn showed it to be in substantial agreement with the curve of expected variability. From Wibaut's curve in Figure 1, an estimate of the percentage of cases in diopter values is given in Table 1.

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TABLE 1

NUMBER OF CASES IN EACH DIOPTER BRACKET ESTIMATED FROM WIBAUT'S CURVE, FIGURE 1

Diopters	No. of Cases	%
+8D.	2	0.07
+7D.	32	1.3
+6D.	95	3.9
+5D.	150	6.2
+4D.	345	14.3
+3D.	408	17.0
+2D.	747	31.6
+1D.	595	24.8
E	21	0.7
− D.	3	0.08
	2,398	

PRESENT STUDY

In an attempt to assemble accurate data on the refractive and ocular findings in the newborn, a detailed study was made of 1,000 eyes under atropine cycloplegia at the University of Arkansas School of Medicine Hospital. No exceptions were made as to color or age of parturition. Of this number, 370 eyes (37 percent) were in white infants, and 630 (63 percent) were in Negroes. There were 10 premature infants, seven whites and three Negroes, making a total of 20 eyes. None of these exhibited any trace of retrolental tissue, nor was there any major gross embryologic defect.

METHOD OF EXAMINATION

Following postdelivery care, one-percent atropine sulfate ointment was instilled in the infants' eyes. This was repeated at six-hour intervals for four times. Six hours following the last atropine instillation, the baby was brought into a dark room in its bassinet.

A small speculum with smooth, rounded blades which could be opened and fixed with a set screw was inserted between the lids. With the speculum properly adjusted, the cornea was in full view and very little motion of the eyeball was evident. With an assistant holding the arms and head, retinoscopy was done at a distance of one-half meter. Prior to removing the speculum, the anterior segment was studied with a Bausch and Lomb hand slitlamp. This was followed with an ophthalmoscopic study of the fundus.

Classifying the types of refractive errors in Table 2, simple hyperopia was found in 439 eyes or 43.9 percent; of this number 168 were white and 271 were Negro. In a ratio of 126 white to 165 Negro, 291 eyes (29.1 percent) were found to have hyperopia with astigmatism.

Simple myopia was found in 118 Negro and 49 white, or a total of 167 eyes (16.7 percent). Myopia associated with astigmatism was represented in 64 eyes or 6.4 percent, with the Negro predominant in a ratio of over three to one. Mixed astigmatism was present in only 29 eyes or 2.9 percent with 22 of them being Negro and seven white. Only three white and five Negro, a total of eight eyes (0.8 percent), comprised the emmetropic group. Dense cataract formations were present bilaterally in one white infant (0.2 percent).

TABLE 2

CLASSIFICATION OF TYPES OF REFRACTIVE ERRORS

Type of Error	White	Negro	Total	%
Simple hyperopia	168	271	439	43.9
Hyperopia with astigmatism	126	165	291	29.1
Simple myopia	49	118	167	16.7
Myopia with astigmatism	15	49	64	6.4
Mixed astigmatism	7	22	29	2.9
Plano	3	5	8	0.8
Cataracts	2	0	2	0.2
Totals	370	630	1,000	100.0

Hyperopia

Analyzing our findings on the strength of refractive errors, Table 3 shows there were 69 eyes (6.9 percent) that had less than one diopter of hyperopia; 29 were white and 40 were Negro. Of 205 eyes or 20.5 percent, a refraction of one to two diopters was found, this representing the greatest number in any diopter group. The count was 78 white and 127 Negro. Two- to three-diopter corrections were next in line with 176 eyes (17.6 percent); of these 75 were white and 101 Negro. The three- to four-diopter category, with one-third white and two-thirds Negro, was represented in 120 eyes or 12 percent.

In the following diopter brackets a decided reduction in the number of eyes in each group will be noted. Only 70 eyes (7.0 percent) measured four to five diopters with a ratio of three white to four Negro. Of almost equal proportions were the 24 white and 22 Negro eyes, making a total of 46 eyes (4.6 percent) requiring a correction of five to six diopters. A refractive error of six to seven diopters was noted in 13 white and 18 Negro or a total of 31 eyes (3.1 percent). In the seven- to eight-diopter group there were only 19 eyes (1.9 percent), nine white and 10 Negro.

As the diopter strength increased, the number of eyes showed a considerable decrease. This is shown with only four white and three Negro eyes (0.7 percent) taking a correction of eight to nine diopters. In the nine to 10 diopter group only two Negro eyes (0.2 percent) were recorded. One white and two Negro eyes (0.3 percent) showed a finding of 10 to 11 diopters. A single Negro eye (0.1 percent) took a correction of 11 to 12 diopters.

From the above group, a total of 749 eyes or 74.9 percent was found to by hyperopic in various strengths ranging from less than one diopter to 12 diopters.

TABLE 3

HYPEROPIA, DIOPTER STRENGTH AND NUMBER OF EYES

Diopters	White	Negro	Total	%
Less than 1	29	40	69	6.9
1–2	78	127	205	20.5
2–3	75	101	176	17.6
3–4	40	80	120	12.0
4–5	30	40	70	7.0
5–6	24	22	46	4.6
6–7	13	18	31	3.1
7–8	9	10	19	1.9
8–9	4	3	7	0.7
9–10	0	2	2	0.2
10–11	1	2	3	0.3
11–12	0	1	1	0.1
			749	74.9

TABLE 4

MYOPIA, DIOPTER STRENGTH AND NUMBER OF EYES

Diopters	White	Negro	Total	%
Less than 1	19	31	50	5.0
1–2	25	41	66	6.6
2–3	9	16	25	2.5
3–4	11	43	54	5.4
4–5	5	23	28	2.8
5–6	2	7	9	0.9
6–7	1	11	12	1.2
7–8	0	1	1	0.1
8–9	0	0	0	0.0
9–10	0	2	2	0.2
10–11	0	3	3	0.3
11–12	0	1	1	0.1
			251	25.1

Myopia

A detailed study of the myopic eyes in Table 4 showed the greatest number required a correction of one to two diopters. Sixty-six eyes (6.6 percent), 25 white and 41 Negro, were in this group. Following in number, 54 eyes (5.4 percent), 11 white and 43 Negro, had an error of three to four diopters. Fifty eyes or five percent, in a proportion of 19 white to 31 Negro, took less than one diopter of correction.

A four- to five-diopter measurement was found in 28 eyes (2.8 percent) with nearly a four to one ratio of Negro over white. Twenty-five eyes (2.5 percent), nine white and 16 Negro, represented the two- to three-diopter bracket. Only nine eyes or 0.9 percent had a correction of five to six diopters, two of them being white and seven Negro.

A slight increase was found in the six- to seven diopter bracket, with 12 eyes (1.2 percent) being the total, 11 Negro and one white. No eyes were found requiring a correction of eight to nine diopters. However, one colored eye (0.1 percent) showed a correction of seven to eight diopters. There was a correction of nine to 10 diopters in two Negro eyes (0.2 percent). Three Negro eyes (0.3 percent) were recorded in the 10 to 11 diopter group. The one remaining myopic eye (0.1 percent) was Negro and the correction was 11 to 12 diopters.

The number of eyes in the myopic classification totaled 251 (25.1 percent). The strength of correction ranged from less than one diopter to 12 diopters.

Astigmatism

The frequency of astigmatism in hyperopia was 28.8 percent as compared to 27.3 percent in the myopic eyes. Mixed astigmatism was present in only 29 eyes (2.9 percent).

Pupillary membranes

The embryologic picture of pupillary membranes was observed in 204 eyes (20.4 percent). This anomaly appeared bilaterally in 196 eyes and unilaterally in eight eyes. One observer[12] has reported these pupillary remnants as high as 95 percent in the newborn. Berliner[13] states that complete persistence of the fetal pupillary membrane is sometimes seen, but this condition was not found in this series of cases.

All of our cases presented incomplete pupillary membranes taking the pattern of single or multiple strands. Some of these strands gave the appearance of being adhered to the anterior lens capsule. A few of these remnants crossed a sector of the pupillary circumference and were attached at both ends, but the majority of them presented unattached ends floating freely in the aqueous chamber.

The attachment of these pupillary remains in the lesser vascular circle of the iris differentiates them from the ones that end in the pupillary border of the iris which are inflammatory in origin. None of the inflammatory type was encountered.

No doubt a greater frequency of pupillary remnants would have been noticed under higher magnification. With the advent of the slitlamp they have been more frequently observed. They are very extensile and do not impede the pupillary movements. Neither do they interfere with vision except in some instances where the membrane has become unusually dense or excites complications in the cornea or lens.

That these strands become absorbed with increasing age is not questioned; but even so, if looked for, they are frequently found in middle life and old age.

Retinal hemorrhages

A number of observers have reported retinal hemorrhages in the newborn; however, their findings, like the refractive findings, have been at great variance.

Jacobs,[14] in 1924, studied 190 cases (380 eyes). Of these, 153 cases were observed in the first 24 hours of life and showed an incidence of retinal hemorrhage of 12.1 percent. Thirty-three infants were examined after the first 24 hours of life and only four showed retinal hemorrhages. In a discussion of Jacobs' paper, Bedell[15] reported his observation of 122 eyes, with nine eyes (7.3 percent) showing retinal hemorrhages.

One observer[16] examined 382 eyes and found bilateral retinal hemorrhages 23 times (6.2 percent). The right eye was involved 14 times and the left eye five times. These observations were made within the first 24 hours of life.

Ehrenfest[17] gave an analysis of the studies made by several observers. He reported that Schleich found retinal hemorrhages in 32 percent of the cases, Paul in 34.5 percent, and Naumoff in 25 percent. He also stated that Coburn examined the fundi of 37 babies, all stillborn or dying within the first three days of life. Seventeen of these babies, or

46 percent, showed retinal hemorrhages, with 13 of them subretinal and four subhyaloid hematomas.

Richman[18] made a study of 531 infants. He reported that 12.2 percent showed retinal hemorrhages. An interesting observation of his was that the incidence of retinal hemorrhages was greater in first-born children (17.5 percent) and greatest in those with forceps delivery (20.6 percent).

McKeown[10] found retinal hemorrhages in 42.1 percent of his cases, and one observer[20] reported as high as 50 percent of the newborn to have hemorrhages of the retina.

This condition was reported in 42.4 percent of Wille's[21] cases and in 32.4 percent of the cases examined by Falls and Jurow.[22] Only recently, since our study was completed, Chace, Merritt, and Bellows[23] have reported finding retinal hemorrhages in 2.6 percent of a large group of newborn infants.

We found among 1,000 eyes a total of 48 eyes (4.8 percent) with retinal hemorrhages. Hemorrhages were present bilaterally in a total of 32 eyes with three white infants involved and 13 Negroes. Six unilateral hemorrhages were distributed equally in the right and left eyes of the white infants. A picture of retinal hemorrhages, unilaterally, was found in 10 Negro eyes in a proportion of four in the right and six in the left.

Neither the method of delivery nor the time in labor had any direct relationship to the incidence of retinal hemorrhages.

These hemorrhages were most frequently located in the posterior portion of the retina, near the macula, and radially around the disc margin adjacent to the vessels. Some were petechial in character, but the majority were large and flame-shaped.

Since the region of the macula was involved most frequently with retinal hemorrhages, it appears to us that they may, in some cases at least, account for certain unexplained amblyopias or macular degenerations of childhood.

TABLE 5

RETINAL HEMORRHAGES

	O.D.	%	O.S.	%	Bilateral	%
White	3	0.3	3	0.3	6	0.6
Negro	4	0.4	6	0.6	26	2.6
Total	7	0.7	9	0.9	32	3.2
Grand total					48 eyes	4.8

MISCELLANEOUS FINDINGS

In 12 eyes there were present on Descemet's membrane folds or striate patterns giving an appearance not unlike the grill figures often seen in the cornea a few days following cataract extractions. These patterns gradually subsided in six to seven days.

A deformity of a colobomatous nature was found in the region of the optic nerve entrance in the left eye of one Negro infant. This defect was in the choroid in close proximity to the nervehead.

One Negro infant was observed with a moderate hydrocephalus which increased rapidly until death five days later. No abnormality or unusual refractive finding was noted.

A lumbar meningocele with bilateral club feet was present at birth in one Negro infant. The eyegrounds were normal and the refractive findings were minor.

A low forceps delivery undoubtedly produced an anterior-chamber hemorrhage in the right eye of one white child. There was complete filling of the chamber with bright red blood except for a small area at the upper limbus. The tension did not rise and a gradual absorption was completed in 10 days.

A rare type of congenital cataract[24] was

found bilaterally in one white infant. The pupil of each eye was filled with a thin, dense, whitish opacity. The central part was calcareous. There were no corneal opacities or persistent pupillary membranes associated with these disc-shaped or ring-form cataracts. The mother and father of this infant had no abnormal ophthalmic findings and the six children previously born to this couple were normal. The personal and family histories did not reveal any factor pertinent to establishing the etiologic factor.

Twenty-five infants had what was classified as one-plus atropine reactions. There was edema of the lids with intense redness of the conjunctiva. Intense reactions to the atropine with localized chemosis and skin involvement occurred in two cases (0.4 percent). No generalized or systemic reactions were encountered. Mild swelling of the lids was noted in 250 eyes or 25 percent. This finding did not appear to be a reaction to medication but to the trauma[25] which accompanied the manipulation in instilling the atropine ointment.

In 26 eyes (2.6 percent), a watery discharge occurred on the third day of life. A microscopic study did not identify any specific organism. This condition was probably due to the chemical conjunctivitis produced by the prophylactic use of silver nitrate.[24]

The corneas were transparent in all cases and the striate patterns mentioned above were the only findings of any significance.

The irises in all Negro eyes were grayish-brown to brown in color. This color was also present in 70 of the white eyes. The remaining 300 eyes in the white infants were bluish-gray to blue in color. The irises in one white infant were deep blue with a marked dilatation of the vessels giving the appearance of a rubeosis.

Summary

1. One thousand eyes of newborn infants were studied under atropine cycloplegia. Of this series, 74.9 percent had hyperopia ranging in strength from less than one diopter to 12 diopters. Over 50 percent of the hyperopic eyes had a correction of less than one diopter to three diopters.

2. Myopia, ranging in strength from less than one diopter to 12 diopters, was present in 25.1 percent of the cases. Eighty-eight percent of the myopic eyes took a correction of less than one diopter to five diopters.

3. Astigmatism was present more frequently in hyperopia (38.8 percent) than in myopia (27.3 percent).

4. Emmetropia is a rare finding in the newborn.

5. Incomplete pupillary membranes were found in 20.4 percent of the cases.

6. A total of 48 eyes (4.8 percent) had retinal hemorrhages usually located in or near the macular area.

7. Disc-shaped or ring-form cataracts were present in two eyes.

8. Hyphema was found in one eye immediately after birth following a forceps delivery.

9. Atropine reactions were noticeably scarce with only four eyes showing a chemosis of the conjunctiva. No systemic reactions to atropine were noted.

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THE EARLY YEARS OF HELMHOLTZ*

In commemoration of the centenary of the invention of the ophthalmoscope

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From the remotest times man had wished to see into the interior of the living eye. For ages, light had been observed coming from the eyes of dogs and cats and other animals, with a reflection so intense as easily to be perceived by the observer. The ancient and prevalent belief was that those luminous eyes developed light of themselves, and, when the animals were irritated, light from their eyes was evolved under the influence of the nervous system. It was also held that the eyes of white rabbits and albinos inherently generated a light. It had long been recognized that the eyes of certain animals, especially those of birds of prey, glisten and sparkle in the dark. Later, it was noted that this was best recognized when the source of light was behind the observer. Following up this result, it was believed that light so placed could be reflected, yet that fact had escaped most observers.

Prevost (Bibliothèque Britannique 1810, pp. 45, 196, 212) announced that the light of the eyes of animals could not be seen in complete darkness, that neither an effort of the will nor irritation could cause it, but it could only be the reflection of the incident light. Another observer reported that it was possible to receive reflections from the eyes of dead animals. Rudolphi observed that we must look into the eyes from a certain direction to perceive the light.

Accordingly, the earlier observers recognized the luminosity of the eye as a phenomenon of reflection without giving an account of the conditions that determined it. From time to time cases of tumor of the eye

* Presented at the 86th annual meeting of the American Ophthalmological Society, Hot Springs, Virginia, June, 1950.

and of eyes without an iris were reported as having reflected light. By the middle of the nineteenth century, all observers, including the foremost physiologist, Johannes Müller, accepted what had been elicited thus far. It was learned, however, that the eyes of the observer must regard those of the patient in a direction nearly parallel to that of the incident rays.

In 1847, W. Cummings, of London, and Brücke found, independently of each other, a method to render the eye luminous when the observer looked in a direction nearly parallel to the incident rays. Brücke had already applied his method to the eyes of animals. At almost the same time, so Wharton Jones wrote five years later, Charles Babbage, a maker of scientific instruments, had shown to him a silvered mirror from which a small portion of the foil had been removed. With this mirror light could be thrown into the eye and, at the same time, the observer could look at the eye through the opening.

To us, today, when the veriest tyro has no difficulty in this respect, it is a wonder that science waited so long for the possibility of seeing the human retina. Some might wish to know who was the inventor of the instrument by which the problem was solved.

To Hermann Helmholtz, a young man, aged 29 years, was given the honor of the discovery. He was the first to give a complete account of the relation between the direction of the incident and emergent rays, and it was he who gave the true explanation of the blackness of the pupil. He employed plain, unsilvered glass, and, to see the retina better, concave lenses. Let us learn briefly the facts of his early years, previously known only to a few.

Hermann Ludwig Ferdinand von Helmholtz was born at Potsdam, near Berlin, August 21, 1821. His father, a teacher of philology and philosophy in the Gymnasium, was a man of high culture and great general intelligence, much respected for the thorough way in which he performed the duties of his position and for the integrity of his character. Hermann's mother was the daughter of a Hanover artillery officer of the name of Penn, a direct descendant of William Penn, the founder of Pennsylvania. The grandmother, on her side, sprang from a family of French refugees of the name of Sauvage. Thus, Helmholtz had German, English, and French blood in his veins. We are free to speculate as to the origin of his talents and to his dignified presence in the mature years.

In a speech delivered in 1891, Helmholtz told something of his early life. For the first seven years he was a weakly boy, confined for long periods to his room and frequently to his bed. He showed great activity of mind, yet he was fond of what amusements were possible during such confinement. His parents gave him much of their time and attention. Picture books amused him and at an early age he read widely. A collection of wooden blocks he specially mentioned as a favorite plaything; he whiled away the time with the blocks, and through them found some geometric conceptions, the first indication of his mathematical genius.

During his early school days he found it difficult to acquire languages, so his parents did much to aid him in studying grammar, together with literature and philosophy. Poetry, however, became easy for him. By eight years of age Hermann was at the Normal School of Potsdam where his rather extraordinary intelligence and learning astonished his masters. Notwithstanding his early difficulties, he could read Homer and, at twelve years of age, Arabic! He read widely with his father and listened to discussions by learned friends of his parents on their visits to his home. Thus he early acquired the proper use of expressions in intellectual and scientific speech. Even in those tender years, his mind opened out to receive the facts of the world of nature.

As his bodily health improved, he was able to take walks with his father, during which his love of the beautiful in nature was encouraged and knowledge of the laws of nature acquired. The scientific books in his

father's library were eagerly perused. He tried experiments, and he constructed a crude optical instrument out of some old spectacle glasses and a small lens. Thus early he worked out problems and drew diagrams relating to the rays of light through a telescope. The optical principles even then occupying his thoughts were expanded and confirmed in his mature years.

In 1838, he left Potsdam Gymnasium to enter the University. An "exceptionally calm and reserved disposition combined with great intellectual enthusiasm" was certified by the rector in his endorsement of the young man's application for admission. Since Hermann had no special training in mathematics, his self-development is all the more remarkable when his proficiency is compared with that of his fellow students.

Desiring to devote his life to the study of physics, he awakened to his vocation early. His father, however, intended that he should study medicine. An uncle obtained admission for him to the Royal Medico-Chirurgical Friedrich-Wilhelm Institute in Berlin, an academy for the medical education of youths of promise, the education given free with the understanding that they would afterwards become surgeons in the Prussian Army. Instruction was given in the medical department of the University and in the Charité Hospital. In due time, after receiving his diploma, Helmholtz became an army surgeon.

Thus, circumstances forced Helmholtz to enter medicine, although his natural propensity was to pursue natural sciences and physics. In his later days, he felt grateful for the training received during his medical studies and experiences.

There was, about this time, a youthful band of students at the Berlin University who were all destined to become eminent in later years. These included Du Bois Reymond, who became Professor of Physiology; Brücke, professor of physiology at Vienna; and Virchow, the pathologist. All these were devoted students of Johannes Müller, who taught physiology and anatomy at the University where Gustave Magnus taught physics. In addition, this band attracted men of promise from all over the world of science. Chemistry, physiology and physics occupied their thoughts. A Physical Society was formed at which free discussion might be carried on, but physics seemed to have been the most frequently discussed subject, Reymond, Helmholtz, and Brücke considering physiological problems from the physical aspect. It was a time of revolution in science, and not a little of the development in after years can be ascribed to that little band of instructor-students. Johannes Müller was the guiding spirit, and it was he who founded the school of modern Experimental Psychology.

There is not time, today, for us to detail all that occupied the minds and the experimentations of these eager young men, except to remark that all conspired to make the way for the achievements of Helmholtz.

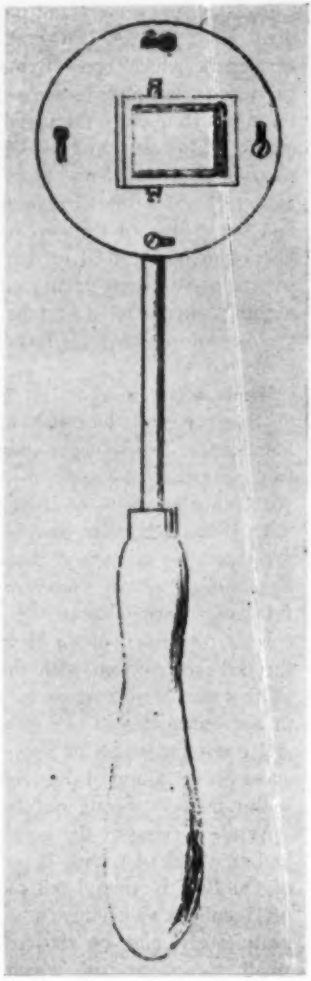
In 1842, Helmholtz, then only twenty-one, presented his inaugural thesis *De Fabrica Systematis Nervosi Evertibratorum*. Only a few years earlier nerve cells had been discovered; it remained for Helmholtz to trace the cell's connection with the nerve fibers. With a simple microscope he was able to see in the corpuscles in the ganglia of leeches and crabs the origin of nerve fibers; thence arose his definition of the origin of the fibers within the cells throughout the entire system.

While serving at the hospital, Helmholtz had an attack of typhus fever. The memoirs of Du Bois Reymond tell of the simplicity of Helmholtz's economy; how he was treated gratuitously, and, on recovery, purchased a small microscope with which to pursue his study of the nerve cells.

This was the beginning of Helmholtz's career as a contributor to science; from then on he published annually at least one paper. His was a great variety of subjects: physiology, physiological optics, acoustics, mathematics, mechanics, and electrical sciences. His years, accordingly, were laborious and

devoid of incidents, and there is not much else to record. There was begun a long life of observation, experimentation, teaching, and lecturing that shall ever stand out as one of the most productive in the history of science.

From Berlin, at the age of twenty-nine, he passed to Koenigsberg, where he continued until 1856 when he was appointed to the chair of physiology in Bonn. This he held until 1859 when, in his thirty-eighth year he became professor of physiology in Heidelberg where he continued for several years until he was called to Berlin as professor of physics. Helmholtz is, perhaps, better known to ophthalmologists for his contribution as a physicist.



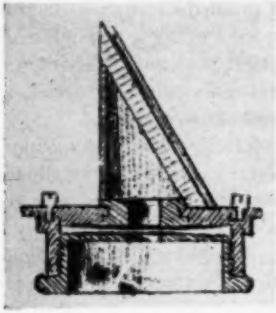


Fig. 1 (Chance). 1851 model of Helmholtz ophthalmoscope.

Thus far, we have learned what was the background of the man's attainment; he was not only a master in medicine, but, as he

swung from one subject to another, the foremost among scientists.

At Koenigsberg, he was engaged in teaching and in investigation, serving as professor of physiology and general pathology. He married Olga von Valkin, of Potsdam, who died soon after his settlement in Koenigsberg. Two children were born in the marriage.

The stream of original papers began to flow in 1850 and increased in volume until Helmholtz moved to Bonn. His discoveries were announced in rapid succession. One is astonished by the number of subjects in which his researches became of first-rate importance. In this period he measured the rate of the nervous impulse, invented the ophthalmoscope, and began the investigations on color and sound forever associated with his name.

It was characteristic of Helmholtz's mind that he was receptive of new impressions and, when an idea occurred to him, his powers were brought persistently upon it; if it involved a problem, he had no rest until the problem was solved. The invention of the ophthalmoscope is a striking example of this trait. He sought to devise the best means of illuminating the eye. His investigations were not pursued merely to show forth the accomplishments of science, but rather that these might become available for humane purposes. Thus, the ophthalmoscope was not intended to serve as an instance of his genius but rather that the little instrument might become of use as a means to study the structure enclosed within the eye and become the daily companion of medical men the world over. This instrument has kept Helmholtz's name green when many of his other more elaborate works have been forgotten or are absorbed in the general body of scientific truths.

In endeavoring to explain to his pupils the emergence of light reflected from the interior of the eye, he turned the problem over in his mind to ascertain the simplest way in which to demonstrate the phenomena. He recalled

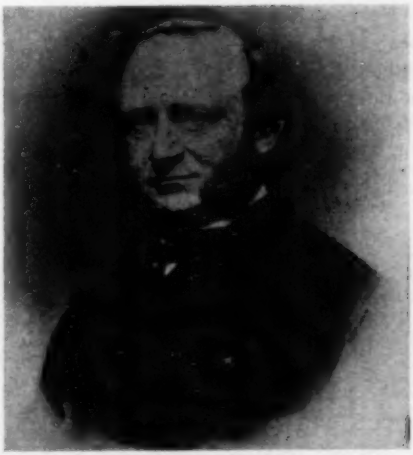


Fig. 2 (Chance). von Brücke, from a late photograph.

how, in his early medical study days, ophthalmologists had great trouble in dealing with certain cases of eye disease, then known as black cataract.

The first ophthalmoscope was of pasteboard spectacle lenses and cover glasses used in microscopic work. Such a contrivance was difficult to use, yet he felt he must succeed, and in eight days he had "the great joy of being the first person who saw before him a living human retina."

To repeat, the invention of an ophthalmoscope proceeded, not from the wish to record any profound investigation, but rather from the desire to exhibit physiologic phenomena. Nor was it a happy guess, but the outcome of a careful thinking over of the facts of vision—and hence an example of Helmholtz's thoroughness. He employed plain, unsilvered glasses and concave lenses to see the retina. That simple instrument, optically, was complete, as we, today, can demonstrate by the pierced mirror we use in skiascopy. Helmholtz believed it could be of service to ophthalmogists not only in regard to the examination of the fundus but also in the observation of changes in intraocular structures, and as a means for accurate estimate of refractive conditions.

Helmholtz was fully aware of the usefulness of his contrivance. In a letter to his father, dated December 17, 1850 (the script is reproduced in Koenigsberger's *Life of Helmholtz*, Vol. III), he wrote that he

had made an invention which may be of real value to Ophthalmology, so simple, requiring no more knowledge than what he had required in Optics in the High School; ridiculous, that people and himself had not found it out long before. With it one can see the blood vessels and the optic nerve, all details of the retina slightly magnified. Now one can define the diseases of the eye hitherto not understood, either in life or at death. And, with his discovery the inner structures of the eye can be investigated as never before. He intended to have an instrument maker construct an instrument more complete than the crude contraption with which he made his first experiments, with which he intends to study patients with the local eye physicians.

Helmholtz claimed the invention as his own, and so reported it before the Berlin Physical Society in December, 1850.

It is reported that when von Graefe first saw the fundus of the living eye with its optic disc and its blood vessels, he cried, in his excitement, "Helmholtz has unfolded to us a new world! What remains to be discovered?" At the Ophthalmological Congress held at Heidelberg in 1858, von Graefe said: "Under our eyes we see the mists disappear which for hundreds of years have clouded the view of our best observers and an unexplored field is won for the healing art." On a cup which von Graefe handed Helmholtz was inscribed "To the Creator of a new Science, to the benefactor of mankind, in thankful remembrance of the invention of the Ophthalmoscope."

BESCHREIBUNG

EINES

AUGEN-SPIEGELS

ZUR UNTERSUCHUNG

DER NETZHAUT IM LEBENDEN AUGE

VON

H. HELMHOLTZ,

PROFESSOR DER PHYSIOLOGIE AN DER UNIVERSITÄT ZU KOENIGSBERG.

BERLIN.

A. FORSTNER'SCHE VERLAGSBUCHHANDLUNG.

(F. JEANRENAUD.)

1851.

Fig. 3 (Chance). Title page of the *Beschreibung*.

To return for a moment to Brücke's interest in the subject. Brücke had for years studied the problem and had observed that reflected light could be emitted from the eye. Had he pursued that discovery, he would have invented the ophthalmoscope, yet it was Helmholtz who was the first to give a complete account of the relation between the directions of the incident and emergent rays, and it was he who gave the true explanation of the blackness of the pupil. It is interesting to note that it was from Brücke's eyes that Helmholtz obtained his first views of the human retina.

There has persisted the dispute as to whom the honor of the invention of the ophthalmoscope should be given. Even today in a personal note to me, Sir John Herbert Parsons would have me "not forget Babbage really

invented the Ophthalmoscope two years before Helmholtz." Babbage did not use lenses with his mirror and therefore could not see the retina clearly. Had Babbage published his discovery, the invention of an ophthalmoscope would have been ascribed to him. We, today, know that the earliest views were obtained by the "indirect method" producing reversal of the images.

In 1851 Helmholtz published a description of his ophthalmoscope, the famous *Beschreibung eines Augen-Spiegels*. That instrument served as the model for many other forms which, innumerable as they have become—and still are being devised—all depend upon the mirror by means of which light is thrown into the eye and reflected back into the eye of the observer.

While at Koenigsberg, Helmholtz put forth the first results of his investigations into acoustics. All his life he had a fondness for music and was a capable pianist and could sing acceptably. It was natural that he would seek to analyze the properties of sound. In 1851 he began the systematic examination of the anatomy and the physical constants of the eye, an examination that culminated in his great work on *Physiological Optics*. It was during this period that he measured the radii of curvature of the cornea and lens, and studied many interesting problems connected with refraction and accommodation, confirming or elucidating the results made by Thomas Young. In 1852, he began to publish his researches in color, which culminated in placing the theory of color on an acceptable basis. Helmholtz's results were announced without his knowledge of what Young had decided; he amply proved the hypotheses of the earlier English scientist and henceforth the theory is designated the "Young-Helmholtz."

The period of his life in Koenigsberg was probably the most thrilling of his days. From the little room he occupied in the anatomic department originated, among other things, not only the ophthalmoscope, but the ophthalmometer and other instruments. Yet had

Fig. 4 (Chance). From a daguerreotype of Helmholtz.

Helmholtz invented only the ophthalmoscope his name would be one of the greatest in science.

The daguerreotype of Helmholtz (fig. 4) was once the property of his great friend Brücke. It dates from about 1864. Brücke's grandson, Ernest von Brücke, formerly Professor of Physiology at Innsbruck, gave it to Dr. Aub. This photograph is not the original from which the picture in Koenigsberger's *Life of Helmholtz* was made; that one was from a collection of Du Bois Reymond.

It is right for you to know that what I have given in this account of this period of Helmholtz's life is but a chronicle of what already has been published by others in biographies of him. Nothing is original with me; this is merely a continuous story gathered from time to time from various sources since the day when I saw at the Wills Hospital a neglected, strange instrument which no one there could show me how to use, and which was lost by the time I became Senior House Surgeon, responsible for the instruments in use. One can imagine my delight, years later, when I was looking up a refer-

ence to Virchow—a great friend of Helmholtz's early days—to find in the 1859 *Edinburgh Medical Journal* in a communication by a special correspondent, this description of the young scientist:

One of the most interesting men in Bonn is unquestionably Professor Helmholtz, the inventor of the Eye-Speculum, an instrument which has opened a new era in scientific ophthalmology. When this little instrument was first invented, many looked upon it merely as an ingenious Continental toy which was destined to play no important part in the practical treatment of disease; but, on the contrary, in the hands of every truly scientific oculist, it has now become absolutely indispensable for the correct diagnosis of affections of the eye. Thus Arlt at Vienna, Graefe of Berlin, and Donders of Utrecht, use it constantly in their examinations of patients, and look upon those who pretend that they can treat ophthalmic affections without its aid as little better than charlatans.

Helmholtz has for some years been Professor of Physiology in Bonn, but has recently been elected to a Chair in the University of Heidelberg, and probably ere this he has left Bonn to make arrangements for commencing his lectures during the ensuing winter. In appearance he is one of the most striking men that I have met on the Continent. He is still quite young, probably between thirty and forty, with a very intellectual countenance, a lofty brow, thin lips, and deep, restless, black eyes. He is very dark, and resembles an Italian more than a German in his general physique. He is a very accomplished man in every respect, and is said to be one of the best mathematicians, as well as one of the best physiologists, in Germany. He treats every subject with which he is engaged in a most masterly and philosophical spirit, and investigates all things independently for himself, never resting content with the traditions of the elder physiologists. In the course of conversation with him. I found that he was particularly interested in the able researches of Professor George Wilson of Edinburgh on the subject of Colour-Blindness. He said that he had repeated many of Professor Wilson's experiments, but had experienced great difficulty in doing so, on account of the rarity of colour-blind people in Germany. He told me of one very curious case of Colour-Blindness which had come under his observation, in which the person recognized more easily differences of colour between two shades of green, —produced by Scheele's green (arsenite of copper) and sap-green, which seemed very slightly dissimilar to ordinary eyes,—than between the two colours of green and red. Helmholtz also suggests the propriety of further investigations being made by means of spectral colours; a hint which I would commend to the attention of the talented Professor of Technology.

My friend, Dr. William R. Sanders of Edinburgh, was the first who introduced this instrument to the British public, at a meeting of the Edinburgh Physiological Society. See his paper published in the *Edinburgh Monthly Journal*, July 1855. For an able description of its structure and use, I may also mention that Professor Jäger of Vienna has recently published an atlas of beautifully colored plates, which show the appearance of the eye in health as well as in all its various diseases, as revealed to us by the Eye-Speculum.

317 South 15th Street (2).

Ophthalmic Miniature

If indeed a man observes letters and other minute objects through the medium of a crystal, either of glass or of other transparent material, set down upon the letters, and if it be the lesser portion of a sphere, whose convexity is towards the eye, and the eye be in the air, far better he sees the letters, and they appear to him larger . . . and therefore, this instrument is useful to the aged and to those having weak eyes.

Roger Bacon, *Opus Majus*, 1268.

EUROPE THROUGH THE OPHTHALMOSCOPE

WILLIAM JOHN HOLMES, M.D.
Honolulu, Hawaii

The XVIth International Congress of Ophthalmology held in London between July 17 and 21, 1950, presented an excellent opportunity to visit leading eye clinics elsewhere in Europe.

My itinerary included 10 European countries with a stopover at the capital city of each. The impressions, and especially the statistics, I've gathered are often sketchy and incomplete. In many instances they reflect my own special interests; in others they represent the individual viewpoints of my various hosts, guides, and interpreters.

My observations were hampered by language difficulties, by the fact that the majority of European Clinics operate on a greatly curtailed, vacation basis during the summer months, and by political barriers which precluded entry into certain countries.

In this report I am presenting only my own personal observations noted during my travels. I am not including the scientific papers, exhibits, and demonstrations, presented before the congress, which in due course of time will be published in a separate volume.

NORWAY

In Oslo, Norway, I visited the ophthalmologic department of the Rijk's Hospital headed by Professor Meiling.

A statistically interesting finding here was the high percentage (90 percent) of exfoliation of the lens epithelium (glaucoma capsulare) in cases of chronic simple glaucoma. Their operation for this condition is iridencleisis.

In Norway, I was also greatly impressed by the stress laid on occupational therapy especially among the pediatric cases of the eye service. It was heartening to see children, both eyes blindfolded, busy themselves under expert guidance with manual tasks of many sorts.

Residencies in ophthalmology in Norway are rather difficult to obtain and are much sought after. In all of Norway, there are only about eight to 10 such residencies available. This is probably the cause of the relative shortage of oculists there. According to one estimate, in all of Norway there are only about 30 eye doctors, 10 of whom reside in Oslo—a city with a population of 430,000.

Before specialization, each physician is obliged to spend at least one year in general practice. As several of the Caucasian patients in the leprosariums of Hawaii are of Norwegian descent, I was surprised to learn that leprosy is quite rare in that country, and that the leper hospital in Bergen has only about 20 patients.

Among social reforms, I was interested to find that they pay a great deal of attention to the dietary regime of school-age children. Each child daily receives a typical Oslo breakfast, consisting of a carrot, an apple or an orange, bread with butter or marmalade, ham, and a glass of milk. Possibly as a result of this, phlyctenular keratoconjunctivitis is rather uncommon.

Elderly people (over 70 years) may avail themselves of free board and lodging in state-supported homes for the rest of their lives.

SWEDEN

One of the most memorable events of my entire trip was a visit to the Karolinska Institute in Stockholm. The architecture and the interior decorating, the combination of stainless steel with glass, the Swedish modern furniture of this beautiful building place it alongside, if not ahead, any of our best hospitals in the United States.

In the absence of Dr. Karpe, chief of ophthalmologic service, Dr. Aurell, his first assistant, was my host. The first place he showed me was the electroretinographic

laboratory. Here, as a special research project, they take routine electroretinogram measurements on all patients. I was impressed by the elaborate apparatus, the painstaking and accurate technical procedure required for this test.

As electroretinography is not known to most United States ophthalmologists, I am enclosing a brief description of its technique and list its principal clinical applications:

"The test is performed with the eyes in a dark-adapted state. The potential is led off from the eye by means of a silver electrode placed in a contact glass, with the indifferent electrode on the forehead. The potential records obtained from the retina on stimulation with light are registered photographically.

"On the basis of many thousands of examinations, a normal electroretinogram and four pathologic types have been ascertained —'subnormal' has been found in cases of high myopia and detachment of the retina; 'negative' has been noted in circulatory disturbances notably thrombosis of the central retinal vein; 'extinguished' has been found in hereditary idiopathic night blindness and in retinitis pigmentosa, even though central visual acuity was still often surprisingly high; 'supernormal' values have been noted in cases of optic neuritis."

The approximate price of such an apparatus in Sweden is $800.00.

Another interesting and highly technical research project that they have under investigation is a study of the limbal blood vessels with successively variable monochromatic (green) lights. In their hands this test has been of prognostic value in cases of uveitis, intraocular foreign bodies, and wounds.

The photographic unit was equipped with separate cameras for external diseases, the iris, and the fundus. The majority of their diagnostic optical instruments were manufactured by Haag Streit of Switzerland. They included slitlamps, perimeters, keratometers, devices for night-vision testing, and others.

In all of the Scandinavian countries and in Holland most refractions are done by the manifest (none cycloplegic) method, often without the use of a retinoscope. In practically all cases, except in young children, they rely on the keratometer, and the patient's subjective answers at the trial case. They feel well satisfied with the accuracy of their results. One cannot help but wonder about the necessity of the painstaking, time-consuming repetitious procedures we use to attain the same end-results in the United States.

About a block distant from the Karolinska Hospital, the Nobel Institute of Neurophysiology, is situated. There Dr. Ragnar Granit is conducting basic experiments on the physiology of the rods and cones, using decerebrate cats for his experimental animals. Dr. Granit's apparatus is even more complicated than the clinical instrument and is equipped with loud speakers, colorimeters, timing devices, and the like.

In Stockholm I also visited the Southern Hospital. To my knowledge, this is the only large hospital (1,200 beds) in the world which is completely duplicated, bed for bed, and facility for facility, with a bomb-proof counterpart, underground. To my query as to what type of surgery they preferred for glaucoma, the resident on the service answered, "None, as we try, if possible, to treat our glaucoma cases by medical means."

Denmark

In Denmark I called on Dr. Ellers, Dr. Rønne, and Dr. Braendstrup at the Rigs Hospitalet in Copenhagen. Dr. Rønne is the son of the famous Danish ophthalmologist whose contributions in the field of glaucoma are known the world over.

In their pathologic laboratory I was impressed with their extensive collection of unmounted, enucleated eyes saved since the clinic was first started. The research value of such a collection is obvious. I enjoyed browsing through Tschernig's former laboratory of physiologic optics and examining

the setup of some of the original experiments of Bjerrum, Edmunds, and Moeller, and others.

I also learned that in Denmark it is mandatory to register every case of cancer through their National Cancer Registry. This system has resulted in improved records and facilitated earlier and better diagnosis.

I was also interested to hear that every Danish child at the age of seven is given a Mantoux test. If this test is negative, he is immunized with B.C.G. vaccination. Scandinavian B.C.G. teams are carrying their worthy preventive work to other countries as well. Such teams are touring southern Europe, Poland, and other war-devastated areas, where they vaccinate children against tuberculosis.

The Netherlands

In Amsterdam, I visited the Wilhelmina Hospital. There I met Prof. W. P. C. Zeeman, known to many United States ophthalmologists as the senior editor of the Ophthalmology Section of *Excerpta Medica*.

Here, as in the Scandinavian countries, the facilities for eye photography are superb. They employ a special full-time artist who paints the regions of the fundus which are not excessible to the camera lens.

An interesting innovation to clinical photography was Placido's disc used in cases of corneal transplantation. By this method, they have been able to photographically demonstrate high degrees of irregular astigmatism, and explain the poor visual results which sometimes followed otherwise successful transplantations.

With regard to transplantation, they were working on the use of scleral tissue for corneal transplants on rabbits. While this work is still highly experimental, they have found that the sclera often clears, and assumes the characteristics of the cornea.

Another interesting research project I saw there was the study of the influence of the vertical contours on the position of the vertical meridian of the retina. Still another project involved the use of a polarized projector and polarized glasses for the study of abnormal retinal correspondence in cases of squint.

From a practical standpoint, I was impressed with a simple, specially constructed electric heating-pad that they use for administering external heat to the eye in various pathologic conditions. This simple, inexpensive device, manufactured by the Solis Company of Bern, Switzerland, has three thermostatically controlled intensities of heat. The pad is tied around the head, plugged into any wall socket, and left in position for half an hour. I understand that this heater will soon be available in the United States. It seems to me that it might prove to be a valuable labor-saving device for hospital and clinic use.

The library of the eye clinic in Amsterdam was up to date. It contained all of the classical textbooks and leading eye journals in Dutch, English, French, and German.

England

The wealth of material, the organization, and the facilities for clinical and research work available in London, make this great center a veritable paradise for the student of ophthalmology. The Moorfields Branch and the Westminster Branch in 1949 report the average number of daily hospital patients at 305, and the out-patients at 1,123. Their operations for hospital patients in 1949 totaled 6,817.

At Moorfields Hospital I was impressed with the attention that was paid to pre- and postoperative orthoptic training. Also at Moorfields I heard a very enlightening dissertation and was shown the facilities of the physiotherapy laboratory by Mr. P. D. Trevor Roper. In this laboratory low-voltage electrotherapy (ionization, galvanism, electrolysis) and high-voltage electrotherapy (shortwave and diathermy) are both used, extensively.

I had the good fortune to observe Mr.

F. A. Williamson Noble perform his modification of the intracapsular cataract operation.

In this operation a frill of conjunctiva is dissected up to the limbus in its upper half. One or more corneoscleral sutures are then inserted. The needle is left in position and a small cut made over it through the sclera. A dural hook is passed underneath the needle, which is withdrawn through the sclera, leaving the stitch in the concavity of the hook and allowing a loop of it to be withdrawn so that the section can be made without cutting it. At the conclusion of the operation the needle is passed through the conjunctiva and the stitch is tied. The subconjunctival frill is secured with a few sutures.

The Institute of Ophthalmology is the postgraduate teaching and research center of the University of London. It is affiliated with Moorfields, Westminster, and the Central Eye Hospital.

At the Institute I have spent a highly instructive afternoon with Prof. H. Davson, who demonstrated the effects of nitrogen mustard and sympathetic stimulation on the intraocular pressure. I have also visited Dr. Hamilton Hartridge, who is well known for his contributions on color vision.

In Scotland, I met the owner of a school of optometry. From him, I have obtained the following figures relating to the cost of glasses and refractions in the United Kingdom. Under the health system the refraction fee of a nonmedical refractionist is 14 shillings. For a medical refractionist this fee is 25 shillings. The dispensing fee for glasses is one pound four shillings. An ordinary frame costs nine shillings and three pence. An average pair of spherical lenses costs nine shillings. The price of a case is one shilling and eight pence. All of this totals two pounds 17 shillings and 11 pence, which at the present rate of the devalued pound amounts to less than nine American dollars for refraction, dispensing fee, and a pair of glasses.

Paris

I arrived in Paris in time for the 57th Annual Congress of the Sociétè Française d'Ophtalmologie. The program of this meeting was presented under four principal headings: Neuro-ophthalmology, night vision, diseases of the uvea, and diseases of the retina.

The subject of night vision has especially been thoroughly investigated by the French group, headed by Professor Jayle of the University of Marseilles. The annual treatise of this society of the current year—a volume numbering over 700 pages—was devoted entirely to the subject of night vision.

At the meeting Professor Jayle exhibited a new, rather complicated apparatus designed for the study of adaptometry, scotopic acuity, sensitivity, perimetry, and flicker. While this instrument in its present form is bulky, it signifies a trend in night visual work toward a series of coördinated examinations, rather than examination of dark adaptation alone.

In Paris, I visited the Hotel Dieu Hospital and the Clinique des Qinze-Vingt. At the latter I observed Mme. Schiff-Wertheimer perform several detachment and intracapsular cataract operations. For the latter, Mme. Schiff used as many as five to six vertically placed corneoscleral sutures which she inserted following delivery of the lens.

For detachment operations, she used an ingenious device consisting of a sterile linen finger cot attached to the sterile sleeve in which the ophthalmoscope is held. This enabled her to move the head of the ophthalmoscope to any desired power, without danger of contaminating herself.

The Clinique des Qinze-Vingt was originally founded by Louis XI as an asylum for the blind. Since then some of France's greatest eye surgeons have received their training there.

At the commercial exhibition held in conjunction with the French congress, I noted

two different, very elaborate, mechanical devices for the removal of the crystalline lens by suction. I also saw and was very favorably impressed with a new beautifully illustrated surgical textbook of the eye by Duborger and Volter.

Switzerland

In Switzerland, I visited the University Eye Clinic at Bern where Professor Goldman is the chief of the eye service and at Zurich, where Professor Amsler heads the ophthalmologic department. At Professor Goldman's Clinic, the principal current topics of investigation were slitlamp microscopy of the angle of the anterior chamber, the vitreous, and fundus.

In Professor Goldman's laboratory I saw several instruments which were designed by him. They included a dark adaptometer and a greatly improved modernized slitlamp and a three-dimensional spherical perimeter—all manufactured by Haag Streit.

Professor Goldman showed me an ingenious device, which he has perfected for the exact localization and extraction of nonmagnetic intraocular foreign bodies. This device consists of two metallic rings, one larger than the other. The rings are applied to the sclera over the suspected location of the foreign body. A series of portable X-ray pictures are then taken at right angles to the rings. The rings are applied and re-applied until the foreign body is seen in the very center of the smaller ring.

This method is simple and practical, and fast. Professor Goldman reports that, in his hands with this technique, cases of nonmagnetic foreign bodies are as amenable to extraction as magnetic foreign bodies.

At present he is investigating the aqueous veins and is engaged in volumetric measurements of the anterior chamber.

Prof. Mark Amsler, chief of ophthalmology at the University of Zurich, is a former assistant of Professor Gonin's. His clinic is modern, well equipped, and is geared to both graduate and undergraduate teaching.

Under his supervision, a variety of conditions are being investigated. These include routine puncture of the anterior chamber, the fluorescein test of the blood—aqueous barrier, qualitative tests of macular vision (with the Amsler charts), prognostic and surgical improvements for retinal detachment operations, and ocular photography.

Professor Amsler considers puncture of the anterior chamber an important part of his examination in cases of iritis, secondary glaucoma, corneal affections, and other conditions. Routine examination of the aqueous in his laboratory includes determinations of total protein content, cell count, cytologic study of the stained aqueous, bacteriologic and immunologic examinations, examination under the dark field and phase, contrast microscope, and additional special examination for scientific purposes.

High up in the Swiss Alps, 6,000 feet above sea level, is Guardaval, the Alpine ophthalmic clinic at Davos. Situated in a story-book setting, surrounded by pine forests and affording an incomparable view of the Alpine Valley, this is one of the most beautifully situated eye hospitals I have ever seen. The clinic provides medical and surgical treatment for eye diseases that are primarily on a tubercular or an allergic basis. They particularly stress the value of general and climatic treatment along with any specific or local treatment that may be given.

Italy

In Rome, I was impressed by the tremendous volume of pathologic cases that are seen daily at the University Eye Clinic.

I observed several operations for chronic simple glaucoma. Their operation for this condition consists of a triple procedure involving cyclodialysis combined with iridectomy and sclerectomy. In their hands this procedure has produced good results. In Rome I also saw several cases of vascular disease of the retina treated every other day with retrobulbar injections of vitamin P and other vasodilators.

Spain

Ophthalmology in Spain is largely associated with the names of two of Europe's most outstanding ophthalmologic personalities—Prof. Thomas Barraquer and Prof. H. Arruga. Dr. Arruga has visited in the United States of America and is personally known to many ophthalmologists here. His *Atlas on Retinal Detachments* is still considered a classic in that field. His latest contribution, a beautifully illustrated *Textbook of Ocular Surgery*, is currently being translated into English.

In Madrid I conferred with Dr. Rios Sasiain who, with Dr. Otero, has made valuable contributions to the subject of night myopia and other problems involving aviation ophthalmology.

Portugal

In Lisbon I visited the Institute of Ophthalmology. In this building the first three stories are occupied by the out-patient department, wards for male and female patients, operating rooms, consulting rooms, kitchen, library, and the like. The fourth floor is reserved entirely for the use of trachomatous patients. The latter are being cared for under more or less isolation conditions.

I was interested to learn that their routine for a cataract operation includes approximately one week's stay in the hospital, preparatory to surgery. On the day of surgery, most patients receive no premedication. The patients are operated upon by the intracapsular method of lens extraction with a small peripheral iridectomy and the use of three conjunctival sutures. Following the operation, the patient walks back to his ward, but does not go to bed until that evening. Their results with this technique are, on the whole, quite successful.

Summary

My short trip to European countries left me with the feeling that our ophthalmologic colleagues, in spite of financial shortages and handicaps imposed by the war, are doing a magnificent job. The 30 odd ophthalmic journals published in several European languages contain countless valuable, thought-provoking clinical and research reports.

Their interest and dexterity in ocular photography have made this field an invaluable adjunct in their undergraduate and graduate training programs.

The diagnostic optical instruments of Haag Streit of Switzerland, Zeiss of Germany, Hamblin of England, and the surgical instruments of Grieshaber of Switzerland are as good as may be found anywhere.

Their hospitality to visitors knows no bounds.

1013 Bishop Street.

SYMPATHETIC OPHTHALMIA*

Following purulent endophthalmitis (postcataract extraction)

Milton M. Scheffler, M.D.
Chicago, Illinois

Case report

T. P., a 54-year-old white man, was admitted to the Illinois Eye and Ear Infirmary on January 27, 1949, for a cataract extraction of the left eye. The vision of the left eye had been failing for four years, and preoperative examination revealed a mature cataract with vision limited to light perception and good projection. The lens of the right eye was clear and corrected vision was 20/30. The laboratory findings were normal, the tear passages were patent, and the conjunctival culture was sterile.

A cataract extraction, left eye, was performed January 29, 1949, utilizing a limbus-based flap, two McLean sutures, and complete iridectomy. During delivery of the lens, the capsule ruptured in the wound lips. The nucleus was expressed and the capsule removed by capsule forceps. The sutures were tied, the anterior chamber was irrigated, and the iris pillars were replaced. Interrupted 4-0 black silk sutures closed the conjunctival flap, and the eye was dressed with atropine sulfate and sulfacetimide ointment.

For the first two days postoperatively, the course was uneventful. There was a mild striate keratitis. The anterior chamber was well formed. There was a black pupil with no lens material visible, and the iris pillars seemed to be in good position.

On the third postoperative day, a decided change was noted. The bulbar conjunctiva became chemotic. The wound was well closed. Purulent material was present about the corneoscleral sutures with corneal infiltration around the nasal suture. The entire cornea was hazy. A marked aqueous beam with many cell clumps and fibrin, and a three-mm. hypopyon was visible in the anterior chamber.

The pupil was dilated to five mm. and no fundus details could be visualized. The impression was that an infection of the anterior segment had occurred along the suture tract. Cultures showed hemolytic Staphylococcus aureus, and sensitivity tests indicated that this organism was sensitive to penicillin and streptomycin.

The patient was given penicillin systemically and subconjunctivally as well as streptomycin locally, in addition to atropine, heat, and foreign protein. On the fourth postoperative day, the patient was given 800 units of streptomycin and 2,500 units of penicillin intravitreally. Penicillin without adrenalin was given subconjunctivally twice daily in the amounts of 250,000 units. This was found to invoke a severe local reaction so that the dosage was reduced to 25,000 units. A total of 750,000 units was given subconjunctivally.

Within a few days purulent exudate filled the area of the coloboma and no red reflex was obtained. The visual acuity was limited to light perception and faulty projection. With continuation of the therapy, the inflammatory process gradually subsided.

On discharge three weeks postoperatively, the left eye revealed a two-plus bulbar reaction, the lower three fourths of the cornea was clear, the iris was atrophic with the pupil bound down and spanned by a gray membrane which also covered the colobomatous area, no red reflex was visible, tactile tension was soft, and visual acuity was light perception with faulty projection.

The corrected visual acuity of the right eye remained 20/30. Other than the development of a hyphema following discharge, the eye gradually became phthisical, soft and remained tender and slightly injected.

* From the Department of Ophthalmology, University of Illinois School of Medicine and the Illinois Eye and Ear Infirmary.

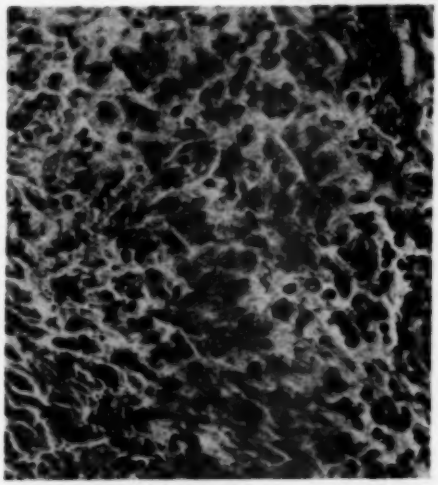


Fig. 1 (Scheffler). High-power view of nodule in skin following uveal pigment sensitivity test. Reaction is similar to that seen in the choroid.

On April 12, 1949, approximately two and one-half months postoperatively, the patient presented himself at the eye clinic of Research and Educational Hospital with the complaints of blurred vision in the right eye of three days' duration. Vision in the right eye was still 20/30, but the globe showed a one-plus bulbar injection, clear cornea, no keratic precipitates, a questionable aqueous ray, fluffy gray Koeppe nodules, and normal fundus. The left eye had not changed except for a marked aqueous beam and cell clumps in the anterior chamber.

The impression was an early sympathetic ophthalmia, and enucleation of the left eye was performed. Therapy for the right eye consisted of aureomycin and salicylates, orally, intravenous typhoid, and atropine locally.

On his discharge, April 18, 1949, there was one-plus ciliary injection, fine keratic precipitates on the lower one third of the cornea, a one-plus aqueous ray with few cell clumps, a few Koeppe nodules on the iris, and no pathologic condition of the fundus.

X-ray studies of the chest revealed some pleural adhesions and the sinuses were slightly cloudy. There was a two-plus reaction to first strength purified protein derivative. Wassermann reaction and blood agglutinations for brucellosis and tularemia were negative. The uveal pigment skin test was positive, showing an accumulation of lymphocytes and epithelioid cells with pigment phagocytosis (fig. 1). By June 14, 1949, the activity of the right eye had completely subsided, and the final visual acuity remained 20/30.

Pathologic description

The enucleated left eye macroscopically measured 18.5 mm. vertically, 20 mm. horizontally, and 22.5 mm. anteroposteriorly. The globe was shrunken with wrinkling of the sclera, especially in the circumcorneal area.

Microscopically, the cornea was quite

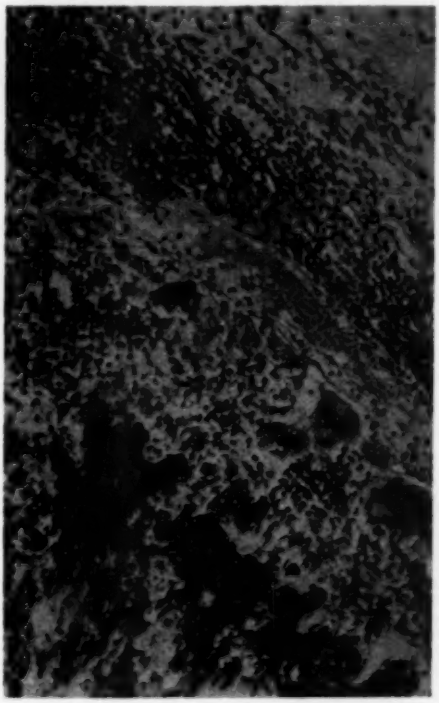


Fig. 2 (Scheffler). Involvement of ciliary body, with presence of giant cells. The inflammatory process has broken through the pigment epithelium.

scarred and vascularized above, with a healed linear penetrating scar just in front of the angle.

The anterior chamber was filled with an albuminous exudate, lymphocytes, and clumps of monocytes showing pigment phagocytosis. The angles were obliterated by broad peripheral anterior synechias.

The entire uveal tract was diffusely thickened and infiltrated with masses of lymphocytes, showing central zones of epithelioid cells with pigment phagocytosis. The infiltration tended to assume nodular characteristics. Only in the ciliary body was an occasional giant cell seen (fig. 2).

In the iris, the posterior layers were primarily involved, leaving the superficial layers comparatively clear. There was a tendency for the inflammatory process to break through the pigment epithelium (fig. 3). The pupil and the area of the surgical coloboma of the iris were occupied by a newly formed connective-tissue membrane continuous with the tissue filling the angle.

In the ciliary body, the vascular layer was involved. In some areas, the inflammatory cells had broken through and involved the pigment epithelium. The choroid was diffusely infiltrated in the external layers leaving the choriocapillary zone comparatively clear (figs. 4 and 5).

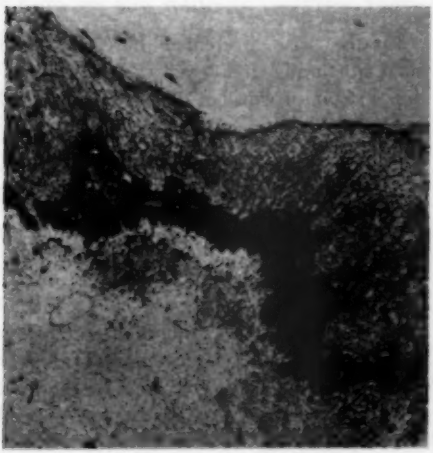


Fig. 3 (Scheffler). Thickened iris showing involvement of the posterior layers which in places have broken through the pigment epithelium.

Fig. 4 (Scheffler). Typical nodules in choroid with choriocapillaris and pigment epithelium of the retina spared.

Some Dalen-Fuchs nodules were present in the pigment epithelium of the retina. A cyclitic membrane was present in the anterior one third of the vitreous cavity containing many new blood vessels and infiltrated with inflammatory cells. The posterior vitreous cavity was filled by an organized inflammatory mass to which the detached retina, folded on itself, was adherent (fig. 6).

Many of the emissaries of the sclera were filled with masses of cells similar to those found in the uveal tract. The superficial vessels in the sclera revealed cuffs of lymphocytes. The optic nerve was atrophic with glial proliferation. No lens material was visualized.

The pathologic diagnosis was sympathetic ophthalmia, secondary to a purulent endophthalmitis following a cataract extraction.

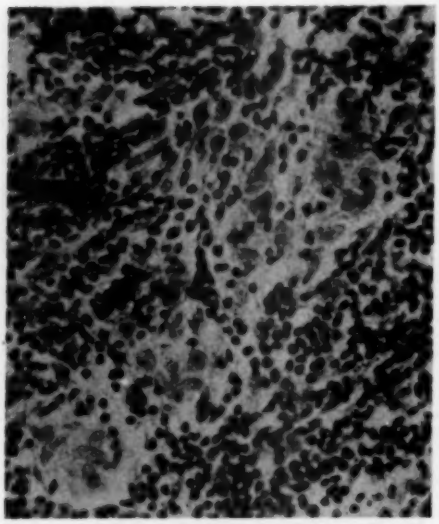


Fig. 5 (Scheffler), High-power view of a choroidal nodule. The epithelioid cells show pigment phagocytosis.

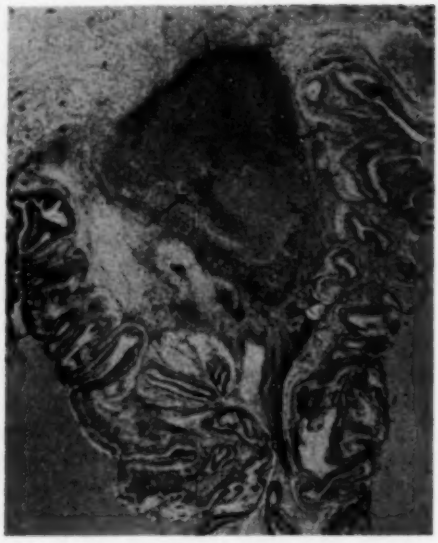


Fig. 6 (Scheffler). Low-power view of organizing inflammatory mass in vitreous cavity with detached retina adherent to it.

Comment

It was formerly thought that a purulent infection within the eye destroyed the uveal tract to such an extent that sympathetic uveitis was made unlikely. However, even in phthisical eyes some remnants of uveal tissue remain. Thus, the protection against sympathetic ophthalmia by suppuration in an injured eye, while generally true, is not absolute. When it does occur, it is sufficiently uncommon to warrant its presentation.

Theobold,[1] in the laboratory of ophthalmic pathology at the Illinois Eye and Ear Infirmary, has not seen a case of sympathetic ophthalmia following a suppurative process. However, several cases have been reported in the literature.

Trowbridge[2] reported three cases of purulent infections of the eye followed by sympathetic ophthalmia. One case was similar to that presented here. Samuels[3] reported three cases of panophthalmitis in a series of 101 cases of sympathetic ophthalmia. Woods[4] has also reported several cases following a suppurative process.

In the case presented here, purulent endophthalmitis following cataract extraction without prolapse of uveal tissue resulted in phthisis bulbi in spite of antibiotic therapy and, two and one-half months later, the development of uveitis in the unoperated eye. Histologic study of the phthisical sympathogenic eye showed the typical findings of sympathetic ophthalmia, and the uveal pigment skin test was positive.

55 East Washington Street (2).

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SURGICAL PRINCIPLES OF CONCOMITANT CONVERGENT STRABISMUS*

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When it becomes evident that nonoperative measures are inadequate for the correction of concomitant convergent strabismus, the surgeon must answer at least these four basic questions: (1) When should the operation be performed? (2) Which muscle or combination of muscles should be selected for operation? (3) Which procedure or procedures are indicated? and (4) How much surgical correction should be done to the muscles which have been selected?

The answers to these questions are difficult to find in the extensive literature on this subject. This is due to the complexity of the problem and the marked individual variability of the patients. A review of the literature reveals a gradual transition from the mechanical concepts of the past toward a more physiologic approach based on a knowledge of the role of the binocular reflexes. This aspect of the subject is discussed by Chavasse[1] and Duke-Elder.[2]

These authors have stressed the fact that the binocular reflexes and the visual acuity at birth are at a relatively low level. These functions improve gradually with the passage of time and the proper use of the eyes, if the visual apparatus is free from factors which interfere with the normal retinal stimuli and with the sensory and motor pathways which are concerned with binocular fixation and movement.

The normal development of binocular fixation takes from five to six years. In view of this, deviations of early onset are more difficult to correct than those which occur relatively late in the developmental period. For the same reason deviations of short duration are more likely to be corrected than those of long duration.

It is the appreciation of these facts which encourages less reliance on the prolonged use of glasses for the correction of the deviation and an increasing tendency for earlier surgical correction.

The magnitude and complexity of this problem make it desirable to have a system which serves as a basis from which to start one's plans in answering the four basic questions which have been proposed. This system must be sufficiently flexible to meet the individual needs of the various patients. Systems based on standard amounts of correction for certain amounts of deviation are no longer recognized as the methods of choice by all.

WHEN TO OPERATE

The answer to this problem is simplified when it is based on the principles of reflex development in childhood. This involves dividing the patients into the early and late groups. In the early group are those whose deviation has been present not longer than approximately 18 months and who are under five years of age. In the late group are those whose deviation has been present two years or longer.

This classification is helpful because the damage done and the recoverability of binocular vision is dependent, in part, on the age of onset and the duration of the deviation.

Figure 1 is an approximation of the gradual improvement in monocular vision. It is assumed that a similar curve exists, but differently timed, for binocular vision. The urgency for surgical correction is increased in the first half of the curve and decreased in the last half, and diminishes beyond the age last shown in the graph.

In patients whose deviation has been present since birth, early but conservative operation is indicated. Occasionally this may be

* From the Department of Ophthalmology, Temple University Medical School. Read before the College of Physicians of Philadelphia, Section on Ophthalmology, February, 1950.

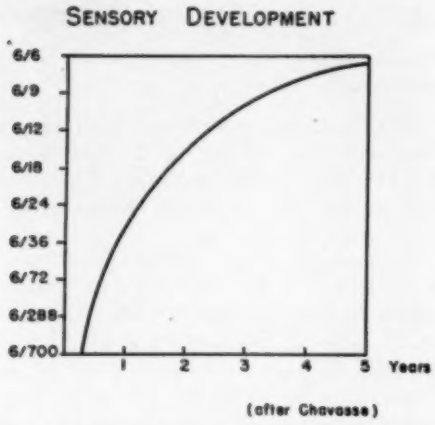


Fig. 1 (Gibson). Normal, increasing visual acuity during the first five years of life.

done at one year of age, usually at 18 months, and occasionally later, depending on the degree of deviation and the clinical progress.

If the onset is from one to three years of age, surgical correction should not be delayed beyond six months in nonimproving patients. If the onset is in the vicinity of three years of age, the urgency of operation is diminished so that a year may be safely spent in nonoperative treatment, as a general rule.

This is due to the fact that the binocular reflex development is partly established by this age, and, hence, is more recoverable than in patients of earlier onset. Likewise, this is the time of onset for the accommodative type of deviation in which the overall prognosis is better. Patients who are corrected at the age of three or four years still have time to develop binocular vision, providing the onset was not at or near birth.

In the cases of long duration, the age of operation is not so important and the operation may be done at any convenient time. Figure 2 is a basic outline from which answers to question one (When should the operation be done?) are derived. It should be pointed out that operations on the very young are not without danger, and the patients should be carefully selected, and procedures should be conservative.

When to Operate

Early Cases	Late Cases
Between 3 and 4 years	As soon as convenient.

Exceptions:

1. younger cases of high degree
2. improving
3. high hyperopia

Fig. 2 (Gibson). The time usually preferred for operation in the early and late cases, with some of the important exceptions to this principle.

Selection of Muscles to Operate

Opinions vary considerably on the selection of muscles for the surgical correction of concomitant strabismus. Since strabismus is an anomaly of binocular fixation, rather than a primary muscular condition, it would seem that the selection of certain muscles might not be important. In some cases, the selection is not important, but in many, it is very important. Therefore, careful thought on this aspect of the subject is indicated not only to obtain the best possible results but also to avoid some of the pitfalls of muscle surgery.

With the exception of a few cases of slight degree, in which one muscle could be operated, the usual procedure is to select two muscles. The question of whether these two muscles should be on the same or on different eyes is determined by the symmetry or asymmetry of the fixation and the lateral rotations.

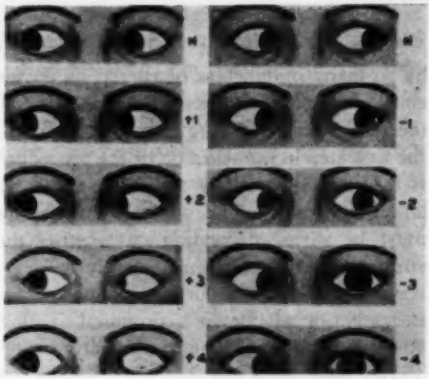
In symmetrical cases, such as true alternators, both internal rectus muscles are selected for operation. In monocular strabismus, the internal and the external rectus of the deviating eye are usually selected. This is true because these two main types are usually accompanied by characteristic abnormal lateral rotations of the eye in ductions and versions depending on which eye fixes in lateral gaze.

Each horizontal rectus will be found to have either normal, excessive, or insufficient action. If these actions are carefully observed and recorded, they will be found to fall into rather characteristic patterns which help in selecting the proper muscles. Abnormal lateral rotations can be graded as plus or minus one, two, three, or four after the method of Prangen,[3] as illustrated in Figure 3.

Figure 3-A and B is a diagrammatic attempt to illustrate the relative position of the eyes in the various degrees of abnormal rotation. In the first example of Figure 3-A, with the eye in dextroversion, the position of the right eye is normal in all the diagrams. The position of the left eye is normal in the top position and each lower position represents one more degree of overaction of the left internal rectus. The plus-four position is very rare.

In Figure 3-B, the right eye is again normal with the eyes in levoversion. The left eye is in the normal position in the top diagram and the varying degrees of underaction of the left external rectus are represented below.

If each of the four muscle actions is graded and placed as in Figure 4, one has a reliable guide for the choice of muscles for surgery. Six examples are given in which some of the various combinations of abnormal lateral excursions are listed. Each number represents the estimation of over- and underaction of various rectus muscles with the V representing the nose.



A B

Fig. 3 (Gibson). (A) The normal action of the right external rectus in dextroversion diagrammatically represented by the normal position of the right eye in all five examples. The top diagram illustrates the normal action of the left internal rectus in dextroversion (N). Below the top examples are the four positions of the left eye in the four grades (+1, +2, +3, and +4) of excessive action of the left internal rectus.

(B) The top example shows the normal position of both eyes in levoversion (N). The action of the right internal rectus is normal in all examples. Below the normal examples are illustrations of the position of the left eye in the four grades (−1, −2, −3, and −4) of underaction of the left external rectus. Reprinted with permission: Arch. Ophth., 23: 477, 1940.

These combinations cover the more common examples which are encountered and have been found to produce the most satisfactory results, by analyzing postoperative results, when the surgical attack is directed at the two most abnormally acting muscles as shown in Figure 4.

STRABISMUS SURGERY — CHOICE OF MUSCLES

1. Symmetrical findings — Symmetrical surgery.
2. Unilateral findings — Unilateral surgery.

	OD			OS		
	Externus	Internus		Internus	Externus	
1.	0	+1	V	+1	0	Bilateral Marginal Myotomy
2.	0	+2	V	+2	0	Bilateral Recession Interni
3.	−1	+3	V	+3	−1	Bilateral Recession Interni
4.	−1	+1	V	+3	−1	Recession Left Internus (Emphasis) Resection Left Externus
5.	0	+1	V	+3	−2	As Above — Equal Amounts
6.	−2	+1	V	+1	−2	Bilateral Resection of Externi

Fig. 4 (Gibson). Six examples of typical abnormal findings. The V represents the patient's nose; the numbers refer to the amount of underaction and overaction of the four horizontal rectus muscles in each typical case. To the right is the type of operative procedure which is usually employed in these different types.

Selection of procedure

Since the amount of correction obtained by so many millimeters of correction varies considerably at different ages and on whether the deviation is of long or short duration, the first step in the selection of the procedure is to divide the patients again into the early and late groups. The operative procedure must be varied depending on whether the surgical attack is designed merely to overcome the deviating influence of abnormal innervation or whether it is proposed to allow for such structural sequela as atony, hypertrophy, or contracture.

In patients of the early group who are presumably free from structural changes in the muscles and permanent sensory abnormalities, in whom binocular vision may yet develop and assist in maintaining the surgically secured alignment, a more conservative procedure will not only suffice but is the method of choice. In symmetrical cases, which meet the requirements, the operation of bilateral marginal myotomy has proven most helpful. In asymmetrical cases a unilateral marginal myotomy of the internal rectus may be combined with a resection of the external rectus.

The operation of marginal myotomy, as described by Chavasse,[1] consists of two incisions placed in the muscle posterior to the tendon directly opposite to each other. The operative technique has been described elsewhere.[4] While the technique is relatively simple, great care must be exercised so as not to get the muscle incisions two short or too long or the results will be unsatisfactory. Equally important is the selection of the patients for this procedure.

The criteria on which the selection for patients for bilateral marginal myotomy is based are: (a) equal vision in each eye—that is, sensory symmetry, (b) equally excessive action of the internal recti—that is, motor symmetry, (c) early cases of short duration—that is, freedom from any significant sequela such as atony and contractures and permanent sensory anomalies, (d) deviation should not exceed 40 degrees—that is, beyond the reach of a conservative procedure. While patients who do not meet these requirements may be improved by marginal myotomy, usually some more extensive procedure is indicated.

In the late cases, bilateral recession has proven to be the most satisfactory procedure in instances in which bilateral excessive action of the internal recti are encountered. If the main abnormal rotational findings are in the external recti, a bilateral resection of the external recti may be employed. In cases in which there is a unilateral preponderance of abnormal rotation, such as is encountered most characteristically in monocular strabismus, a recession of the internal rectus is most advantageously combined with a resection of the external rectus.

While other types of operations, such as tucks, cinches, and advancements, and the various weakening procedures, may have their proper place, they have been found unnecessary in correcting the usual deviations. It is most probable that the selection of the various types of procedure is secondary to the importance of selecting the proper muscle, time, and amount of operative correction.

The reason that these different procedures

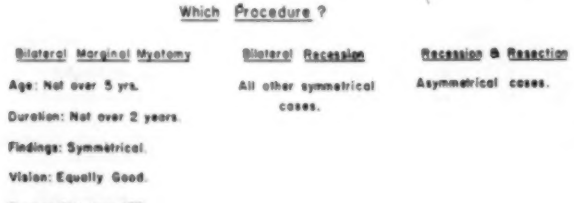


Fig. 5 (Gibson). A summary of the procedure to use in typical cases. Special findings in unusual cases may require departure from the usual procedure.

are recommended is to be found in the reflex development of the patient. The conservative operation of marginal myotomy is recommended because, if and when it produces the desired result, binocular vision will develop and be of assistance in the maintenance of parallelism in the early group. In the late group where less reliance can be placed on the binocular reflexes, more extensive surgery is necessary not only to overcome the muscular but also the sensory abnormalities.

The amount of correction

The most difficult and important question to answer is how much surgical correction should be done. This is particularly true since all patients do not respond identically.

The amount of surgical correction in the early cases in which bilateral marginal myotomy is employed is easy to determine because all amounts of deviation from 10 to 40 degrees in the properly selected and properly performed cases will respond to the same amount of surgical correction. Graduated doses of muscle surgery are not necessary.

The length of the incision in the muscle is made so that only the central three mm. of the muscle remains uncut regardless of the amount of deviation. This is particularly true in the early instances where the amount of deviation is variable. This is so because the only force which has to be overcome, in most instances, is the hyperinnervation of the internal rectus. This operation renders the internal recti incapable of excessive response.

When marginal myotomies are contraindicated and recessions and resections are employed in the early group, the amount of correction should be reduced by about one-third of that which would be employed in similar amounts of deviation in the late group.

In contrast to the early group graduated amounts of operative treatment are necessary in the late group. It is admitted that more correction is necessary for marked deviations than for slight ones. It is also true that precise number of millimeters of correction yield variable results. It is also true that one cannot have a certain amount of surgical correction for each degree of deviation. While each surgeon has his own concept of how to approach this problem, answers in the literature leave much to be desired on this question.

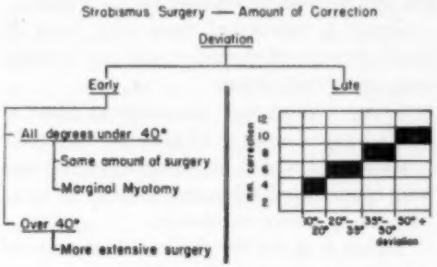


Fig. 6 (Gibson). A summary of the amount of correction. The early cases showing under 40 degrees of deviation require no graduation in the amount of surgical correction. The cases which show more than 40 degrees of deviation require more extensive surgery. The late cases require graduated amounts of correction as illustrated for an average patient. This amount is sometimes scaled up or down when special features of the case warrant it.

The approach which I have found most workable in the preoperative determination of how much correction should be done may be described as a biphasic process. The first phase is to determine how much correction will produce the best results most frequently. This has been done by reviewing the records to learn how much correction usually produced the best results in the various degrees of deviation. The second phase may be described as an estimation of what particular problems are present in a given case which would require that the average amount of correction be scaled up or down.

In the first phase of this estimation, it has been found helpful to divide the patients in the late group into four groups, depending on the amount of deviation and the amount of total operative correction (see chart on the right side of figure 6). This total opera-

tive correction is almost always divided between the two muscles which have been selected.

Group 1 consists of patients whose deviations are from 10 to 20 degrees. They usually do best when from four to six mm. of total operative correction is divided between the two muscles which have been selected.

Group 2 consists of cases with from 20 to 35 degrees of deviation and six to eight mm. are usually done.

Group 3, those with deviations of from 35 to 50 degrees, eight to 10 mm. are employed.

Group 4, which represents those cases with more than 50 degrees, requires 10 to 12 mm. of operative correction.

Figure 6 shows the graduated amounts of surgery employed in these late cases.

These average amounts of correction are employed in average cases. When certain features are present, the amount is scaled up or down. The most frequent cause for decreasing the standard amount is the presence of high hyperopia. Since these cases tend to improve with time and subsequently diverge, caution is more than indicated.

The presence of any visible lesion of the media, fundus, or optic nerve is an indication for less than average amount. A remote convergence near point is a signal for conservatism. The presence of very excessive action of the internal recti is an indication for more than the average amount of correction. The presence of muscular contracture requires more than the average amount.

The presence of amblyopia ex anopsia requires that considerable judgment be exercised. This is true because it is well known that, in some cases of marked amblyopia, there is danger of postoperative divergent deviation and in some there is danger of marked undercorrection.

The first possibility requires that the amount of operative correction be scaled down; the second, that the amount be scaled up. The decision of which this should be is vital, and may be determined by both preoperative and operative estimation of the amount of contracture and atony which is present in the muscles.

If an amblyopic eye has been found to have relatively normal motility, a conservative procedure is indicated; if the rotation tests reveal markedly abnormal rotations, however, a more extensive operation is indicated because the contracture of the internal rectus will tend to overcome the tendency of amblyopic eyes to become divergent at later dates.

One of the most important points, as yet not settled, is whether the surgery should be modified according to the presence or absence of abnormal retinal correspondence.

This general scheme is a workable approach to the problem of deciding how much operative correction should be done. It is summarized in Figure 6. While it is not infallible it serves as a practical working basis.

Results

Having outlined the general principles of a plan which has been evolved for answering the questions of when, which muscles, which procedure, and how much should be done, the question which arises is: How reliable are they in actual practice? This question does not lend itself readily to statistical analysis since the criteria of success are not sharply defined and because the end results of a procedure change considerably after the passage of varying periods of time. Furthermore, certain patients have complications over which the surgeon has no control.

In order to discuss the results, it is necessary again to divide the early and late groups, and to discuss motor and sensory success independently.

In the early cases, the objective is to correct the deviation so that the eye is at or close to the primary position, and do so without interfering with the conjugate and disjugate movements. In this group these motor objectives can be obtained in approximately 80 percent of the patients at the time of the first operation. In approximately 15 percent, a residual deviation of five to seven degrees remains, and in five percent the motor results are unsatisfactory and secondary

operations are frequently necessary.

The sensory results are nowhere near so satisfactory, since only approximately 30 percent of the patients develop binocular vision. The results in the late cases are not so satisfactory, although approximately 80 percent of the late cases obtained a satisfactory cosmetic result so that further surgery was not necessary. These are the patients whose residual deviations range from zero to 12 prism diopters of deviation. The sensory results are uniformly poor in that only about 10 percent of these patients obtained binocular vision. These figures are interpreted not as an absolute expression of the surgical accuracy but rather as an indication of the patients' sensory possibilities.

In both groups, the final position is dependent on the sensory development before the onset of the deviation and the length of time that deviation was present. In those patients whose sensory anomalies are permanently abnormal, the surgeon is operating under a very unfair disadvantage.

In conclusion this report may be considered as an appeal for a systematic plan for muscle surgery in which the patients are divided into two groups dependent on their sensory possibilities. The choice of muscles, the time of operation, the amount of operation, and the kind of operation are selected on the basis of the sensory possibilities—with a plea for early surgery in most instances.

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THE ULTRASTRUCTURE OF THE CORNEA AND THE LENS STUDIED BY MEANS OF THE ELECTRONIC MICROSCOPE*

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With the exception of the work of Hollande, the study of the ultrastructure of living protoplasmic material is carried out only by means of indirect methods of examination. Indeed, since the form and dimensions of the "microsomes" of Claude (one of the constituents of protoplasmic ultrastructure) are beyond the limits of optical microscopic visibility, every direct method is doomed to failure.

The indirect methods in use are Svedberg's ultracentrifugation, the observation of double refraction and that of diffraction (double absorption, dichroism). Another method is based on diffraction by means of X rays, derived from the technique which Laue has applied to crystalline powders. From the microphotographs thus obtained, the spacing of the fibers and molecular network may be obtained. All of these extremely complicated methods, calling for very specialized technical knowledge and much experience on the part of the operator, frequently give but doubtful results, whose interpretation is far from easy.

Thanks to the electronic microscope, the study of protoplasmic ultrastructure can now really be undertaken systematically, using well-defined techniques, of which the results are constant and reliable.

Furthermore, the use of the electronic microscope being a direct method, the interpretation of the results is much easier. The great similarity of results obtained by different authors, who have studied protoplasmic

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ultrastructure using various biologic materials, enables the true value of this method to be appreciated.

The authors especially interested in such study are Claude, who can be considered the pioneer of this technique; Faure-Fremiett and Bessis, who have studied the protoplasm of the amoebocytes of the triton and the snail; Hall and his collaborators, who have examined the muscle cell; Reed and Rudall, who have described the cuticle of the earthworm; Bessis and Bricka, who have concerned themselves with the thrombocytes; and Sebruyns, who have studied the renal and hepatic tissue.

Technique

I have employed the "double print" technique, which I have developed and applied to electronic histology. This procedure consists in taking a negative imprint of the surface to be studied, with the aid of a solution of plastic material. Since this imprint is not to be examined by the electronic microscope, the plastic material can be laid on thickly, which facilitates its subsequent removal—this is a very real advantage.

I use a five-percent solution of collodion in a mixture of equal parts of alcohol and ether. The collodion is applied with a glass rod and left to evaporate for 10 to 15 minutes. If not spontaneously detached, the collodion pellicle is then pulled off with forceps. The negative image thus obtained is used to make the positive imprint. The latter must be extremely thin, since it is going to be examined by the electronic method.

The collodion pellicle, bearing the negative imprint, is placed in the empty space of an evaporating chamber, directly above a crucible containing silica, and is turned to face this crucible. The silica, evaporated by electric heating of the crucible, condenses upon the imprint in the form of a fine film, which clings faithfully to the relief.

The double imprint is thus completed. But the collodion, being too thick to allow the passage of electrons, must be eliminated. To this end the double imprint is cut into small squares (about four sq. mm. in area) which are dropped into a container holding amylacetate or acetone. This dissolution, on which particular care is expended, must be continued for a sufficient period (one-half to one hour) so that no traces of collodion appear on the microphotographs.

The next step is to transfer the preparation to the object holder or capsule. This capsule is taken by the edge and delicately slipped underneath the preparation, thereby extracting it from the amylacetate.

Each capsule is first examined under the ordinary optic microscope for the double purpose of making sure that the positive print is well displayed (the least fold will make any study by means of the electronic microscope impossible) and of placing precisely the preparation which is to be investigated. The final step is the electronic photography.

With the aid of this technique I have studied the ultrastructure of the cornea, lens, and capsule of the ox eye, fixed by phosphotungstic acid (four-percent aqueous solution).

The cornea was cross cut in order to obtain as large a section as possible of the epithelium and corneal tissue itself. A print of the lens capsule was taken in situ, after which the lens was decapsulated and sectioned through the frontal plane, perpendicular to the center of the anteroposterior axis. An imprint was taken from the surface thus obtained.

Fixation

I have studied the action of diverse classical fixatives—Bouin's liquid, absolute alcohol, 10-percent formalin and formol alcohol. Not one of these fixatives has been found satisfactory, in the sense that the very different structures, resulting from their use, are rather artefacts, only giving in part a true indication of the structures really existing in the living cell.

For study by the electronic microscope the fixation of biologic material is, however, of extreme importance; the fixative must in-

deed furnish structures which are images of reality. Phosphotungstic acid (four-percent) alone has enabled me to obtain well-defined and constant images, which correspond, furthermore, with the images of the cytoplasmic ultrastructure described by Hollande who, however, employs another technique and has been able to control his results on unfixed material.

Fig. 1 (Sebruyns). The basal cells of the corneal epithelium present a spongioid appearance.

Description of the preparations

I. The cornea

1. *The epithelium.* The print of the cells of the basal layer gives the appearance of a substance more or less homogeneous, completely full of round or oval vacuoles of different size, presenting a spongioid appearance (fig. 1). The ultrastructure of these cells is not, however, from every point of view, identical with that which we have found in the renal and hepatic cells. It is notably more fine and the vacuoles achieve a certain orientation which can be observed (fig. 1) as more or less horizontal vacuolar trails.

The imprint of the cytoplasm of the cells of the middle layer has an aspect which resembles that of the basal cells, but the ultrastructure is even more fine. The vacuoles are

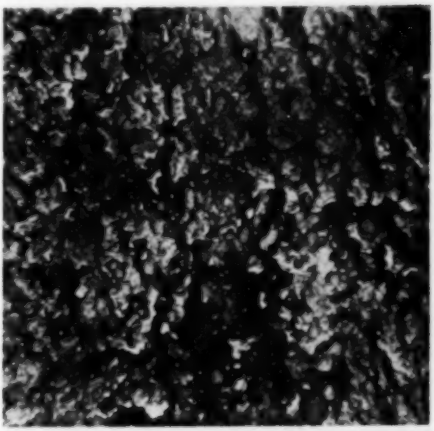

Fig. 2 (Sebruyns). The vacuoles of the cells of the middle layer of the corneal epithelium are smaller and more regular.

smaller and more regular and their orientation more clearly marked (fig. 2).

The superficial cells, on the contrary, have an altogether different structure. The imprint (fig. 3) reveals the existence of a substance almost homogeneous: the cytoplasm is uniform, smooth, and presents no vacuoles.

2. *The tissue of the cornea proper.* The imprint of this tissue shows the typical disposition of the conjunctival fibrils. We draw attention to the spiral structure of the tracts

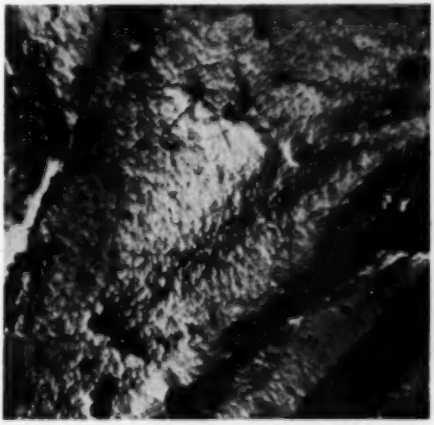

Fig. 3 (Sebruyns). The superficial cells of the corneal epithelium show a smooth, uniform cytoplasm with no vacuoles.

Fig. 4 (Sebruyns). The tissue of the cornea proper.

which compose the fibrils and which are arranged like a solenoid, following the longitudinal axis of the fibril (figs. 4 and 5). The regularity of these fibrils and their parallel disposition are remarkable.

II. The crystalline lens

1. *The capsule.* The imprint gives images which do not in the least resemble those of the cytoplasm of the renal or hepatic cells. The vacuoles are more or less regular and generally very fine. Their aspect is strikingly reminiscent of that of the middle layer of cells of the corneal epithelium (figs. 6 and 7).

2. *The lens.* The imprints of the lens section offer totally different aspects, according to whether they originate from the cortical zone or the nucleus.

The appearance of the cytoplasm of the cortical cells resembles to a certain extent that of the cytoplasm of the renal or hepatic cells (fig. 8). The vacuoles have diverse forms and no definite disposition; they take the classical spongioid appearance.

The imprints taken at the level of the nucleus reveal, on the other hand, a special structure, which until now has never been described. All the vacuoles have a well-defined rectangular form and are disposed in strictly parallel, distinctly orientated rows (fig. 9). This structure is most marked at the center of the lens and gradually disappears as the periphery is approached.

Discussion

Even before the use of the electronic microscope, various authors had studied the

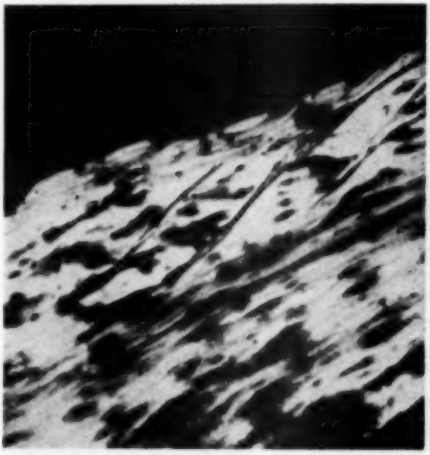

Fig. 5 (Sebruyns). The tissue of the cornea proper. Note the spiral structure of the tracts which compose the conjunctival fibrils and which are arranged like a solenoid. (See also Figure 4.)

Fig. 6 (Sebruyns). The capsule of the crystalline lens. The vacuoles are more or less regular and are generally very fine.

ultrastructure of both vegetable and animal karyoplasm and cytoplasm (Hollande, Frey-Wyssling). Indeed, Hollande had described several techniques, which permitted the recognition of the ultrastructure of the cell and of the nucleus by means of the optical microscope and in vivo.

Certain authors consider the cytoplasm and the nucleus of the cells as total elements composed entirely of colloidal substances optically empty and structureless, forming homogeneous masses in a condition of gel and sol.

This conception is erroneous, for Hollande has established the existence, in the cytoplasm and karyoplasm, of capillary tubules, at the surface of which are arranged in spiral fashion tiny granulations, sometimes barely visible, and are connected by fine tracts.

These tubules usually have a diameter of 0.3 μ, to 0.6 μ, or even smaller dimensions. Their walls are transparent and their contents most often colorless.

Forming in certain cases continuous systems, they describe numerous circumvolutions to which Hollande has given the name of spiremoids when they are in the nucleus and solenosomes when in the cytoplasm. The spiremoids and solenosomes are hollow elements filled with diverse substances, liquid or semiliquid.

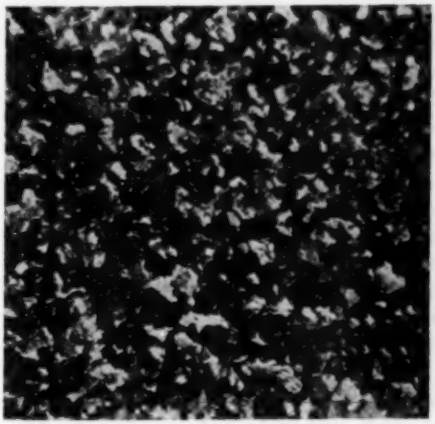

Fig. 8 (Sebruyns). The lens. The appearance of the cytoplasm of the cortical cells is somewhat similar to that of the cytoplasm of renal or hepatic cells.

We may thus conclude that the cytoplasmic and nuclear protoplasm of every vegetable or animal cell is organized.

Research with the electronic microscope, thanks above all to the "double imprint" technique, confirms these discoveries, for

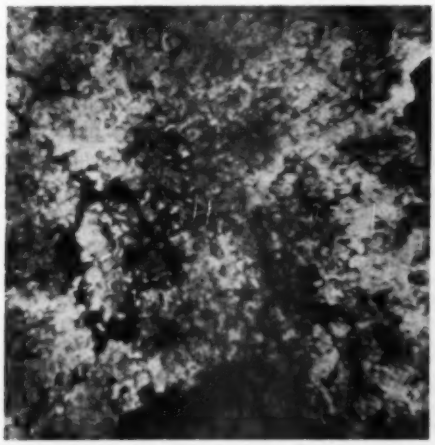

Fig. 7 (Sebruyns). The capsule of the crystalline lens. The appearance of the vacuoles resembles strikingly that of the middle layer of cells of the corneal epithelium.

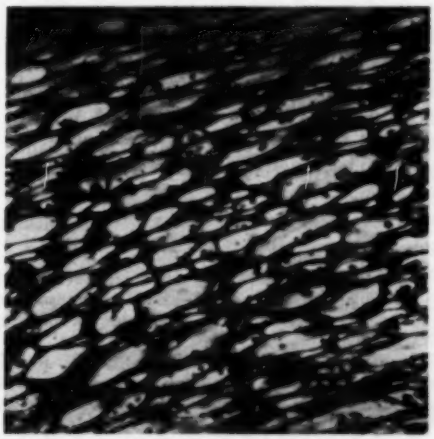

Fig. 9 (Sebruyns). The lens. All the vacuoles have a well-defined rectangular form and are disposed in parallel, distinctly orientated rows.

the ultrastructure is revealed to us in a distinct and indisputable fashion. As shown by our microphotographs, this ultrastructure is, however, not altogether the same for all cells; remarkable differences exist, very probably in accordance with the physiologic role of the tissues.

All the ocular tissues, which have been studied, belong to the optical part, of which the first property required is transparency. I believe that I can explain their ultrastructure precisely according to this indispensable property.

The corneal epithelial cells are so constructed that the rays of light which transverse them are refracted to a minimal extent. Their ultrastructure is indeed infinitely more regular when one compares it, for example, to that of the renal or hepatic cell.

The helicoid disposition of the conjunctival fibrils of the corneal tissue can equally well be considered in accord with transparency, for it is known that the helicoid molecular disposition of certain crystals confers upon them the same property.

The lens capsule provides another example of this regular disposition which results in transparency. In addition, my hypothesis is reinforced by observations made on the lens—the cortical zone, whose index of refraction (1.388) is less than that of the nucleus (1.410), has an ultrastructure noticeably less regular and the cytoplasm of the lens fibers offers a typical aspect, which must in all probability be considered in accordance with the exigencies of their transparency.

The compact and uniform structure of the superficial cells of the corneal epithelium, forming a real protective screen, may help in preventing the penetration of any microbe or other foreign body, and the numerous vacuoles of the capsule enable the passage of the aqueous humor, which provides for the nutrition of the lens.

The rectangular vacuoles of the crystalline fibers of the nucleus accord with the viscous character of the nucleus; while conserving a regular form and normal orientation, they must permit the physiologic power of the lens to change its shape.

In all probability one may expect evident deviations from the normal ultrastructure in diseased tissues, in cases of cataract or corneal ulcer for instance. This is what I hope to establish in further work.

Summary

I have studied with the electronic microscope the cytoplasmic ultrastructure of the cornea and the lens, employing for this purpose the technique known as "the double imprint."

From this research, it appears that the ultrastructure of the corneal epithelium and the tissue proper of the capsule and the lens is directly correlated with their physiologic properties—first of all the transparency; then, for the cornea, some protection, and for the lens, the permeability and the power of changing shape.

Avenue Pasteur 2.

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NOTES, CASES, INSTRUMENTS

A NEW HOLDER AND PINS FOR RETINAL DETACHMENT OPERATION*

R. Townley Paton, M.D.
AND
Herbert M. Katzin, M.D.
New York

A newly designed holder for inserting diathermy pins similar to the original Safar pins has been used with success at the Manhattan Eye, Ear, Nose, and Throat Hospital during the past year.

The handle is easily sterilized by immersion in an antiseptic solution. It has a sliding catch to engage and release the pin. The tip of the holder is curved backward in order to enable the surgeon to approach the posterior aspect of the globe with ease. The metal parts are insulated from the current which passes through the pin.

A convenient metal rack is provided for storage and sterilization of the pins which are available in several sizes (0.5, 1.0, 2.5 mm.). The pins can be picked from the rack by the holder. An especially designed forceps is supplied for easy manipulation and removal of the pins from the sclera.

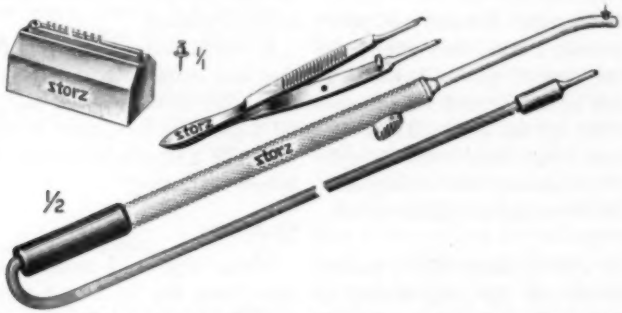

Fig. 1 (Paton and Katzin). Holder and pins for retinal detachment operation.

* From the Eye Bank for Sight Restoration, Inc. Manufactured by the Storz Instrument Company, Saint Louis.

REFRACTION CLINIC*

Discussion by

Albert E. Sloane, M.D.†
Boston, Massachusetts

The reason for presenting this case is to show that certain minor inflammations of the lid may have a definite influence on the refraction of the eye.

This is a man, aged 35 years who was refracted by me on February 12, 1946: R.E., with a +0.5D. sph. = 20/20; L.E., with a +0.5D. sph. = 20/20. At that time, he showed normal vision in both eyes and a small hyperopic refractive error. I next saw him on June 2, 1947, because of an inflammation of the left upper lid, at which time there was found a large infected chalazion from which pus had already started draining.

He was treated with hot compresses and local antiseptic applications, and then two weeks later, when the inflammation had quieted down, the remaining chalazion was curetted. The following day, quite by accident, he noted that the vision in his left eye was very blurred. At that time, it was found that visual acuity in his left eye was 20/200, improved to 20/30 with a pinhole.

* From the House Officers' Teaching Clinic, Massachusetts Eye and Ear Infirmary.
† Director of Department of Refraction.

An irregular reflex, as viewed through a retinoscope, was obtained from the cornea. The fundus was entirely normal but was seen as though through an astigmatic error.

Slitlamp revealed normal findings. There was no staining of the cornea and no lesion visible by the slitlamp to account for reduced vision. Refraction at that time revealed that −2.0D. cyl. ax. 80° improved the vision to 20/30.

The following day I had him refracted by two doctors who noted these findings for the left eye. (Dr. A): −1.5D. cyl. ax. 60° (keratometer) = 20/20; −2.0D. cyl. ax. 60° = 20/20. (Dr. B): −2.0D. cyl. ax. 60° (keratometer) = 20/20; −0.25D. sph. ⊂ −2.0D. cyl. ax. 65° = 20/20. Naked vision on this second day was 20/70.

On the third day after discovery of poor vision by the patient, I asked two other people to refract the patient: (Dr. C) recorded the naked vision as 20/50, and found subjectively: −1.75D. cyl. ax. 75° = 20/20−3, and by keratometer he found −1.75D. cyl. ax. 75°. (Dr. D) recorded the findings as: Naked vision 20/70; using a −2.5D. cyl. ax. 66° = 20/20−2.

On June 30, approximately three weeks after the discovery of the poor vision, a slight amount of swelling (not to a significant degree) was still present in the lid. The naked visual acuity was recorded as 20/50, slow, and still a −1.5D. cyl. ax. 75° = 20/20 was present. Tension was 19 mm. Hg (Schiøtz) in both eyes at that time.

The patient was then seen again on October 9, 1947, at which time the naked visual acuity in the left eye was again 20/20, but a small residual astigmatic error remained of the magnitude (+0.25D. sph. ⊂ −0.5D. cyl. ax. 75°) which gave the patient 20/20 plus vision. From the period of time June 2nd through June 30th, he did not appear to be better.

Discussion

The purpose in presenting this case is, first of all, to show that a refractive error can be induced by pressure from the lid and, as this case well demonstrates, the refractive error so produced is variable and somewhat inconsistent. Therefore, it would be a mistake to prescribe glasses on the basis of findings present at the time a lid is inflamed and swollen.

Very often, a patient comes to our office to be refracted and one finds a tarsal cyst present. It would appear that the refraction had better be postponed, and the tarsal cyst removed.

This would give another attitude as to the undesirability of keeping a chalazion. One can state that an untreated chalazion can do no harm. Still, one would have to admit that one is also not able to prescribe the most effective refractive correction while the chalazion is present.

It would also appear from this case study that one must wait a reasonable period of time after all the swelling has gone from the lid to perform refraction. Perhaps six weeks would be a reasonable time to allow to lapse before refracting.

Question

House Officer: I would think that pressure from the lid would produce a "with the rule astigmatism."

Answer

Dr. Sloane: One would ordinarily expect this to be the case. Perhaps the explanation lies in the fact that the swelling was not in midline but rather to one side.

Question

House Officer: What was the significance of the tension reading?

Answer

Dr. Sloane: It has been suggested that eyes with a very low intraocular pressure are more likely to have the curvature of the cornea influenced.

243 Charles Street (14).

DIAGNOSIS OF POLYCYTHEMIA FROM THE ANAMNESIS AND EXTERNAL EYE SYMPTOMS

EDMUND CARTER-ROSENHAUCH, M.D.
New York

Eye symptoms in polycythemia are typical. The reddish-blue, cyanotic skin color is found also on the eyelids. A similar color is also found on the eye conjunctiva. There is, however, no inflammation. The examination of the fundus of the eye is significant; the veins and the arteries are engorged, they are reddish-blue and cyanotic; there is frequently a choked disc. Hemorrhages occur seldom. Vision is usually normal.

The ophthalmologist sees such patients, though they may often seek his advice not because of their blood disease but because they think that they suffer from conjunctivitis.

During the last few years I observed two patients with polycythemia who came to my office with such characteristic histories and eye symptoms that a description appears of interest.

REPORT OF CASES

CASE 1

A. F., aged 33 years, a Jewess, ever since she left a German concentration camp, had been complaining of being tired. She was treated by a physician but no diagnosis of polycythemia was suspected.

She came to my office because her eyes had been red and tearing. On further questioning she mentioned that the eyes did not actually tear but they look as if they are tearing. She had no other symptoms except that she complained that her eyes had changed in appearance, had become rather smaller and red.

Examination of eyes. The eyelids, as well as the skin of the forehead and on the face, had a pronounced suntan; the upper lids of both eyes showed a drooping; the eyelid slit was smaller than usual; the caruncle was swollen, cyanotic, and raised between the eyelids in the nasal corner so that it was visible without lifting the eyelids.

The external appearance of the eyes at first gave the impression of trachoma. After turning up the upper lid, however, the conjunctiva was found to be smooth, not hypertrophic and without grains, though cyanotic.

The cornea and the anterior chamber, the pupil, the visual fields, vision, and tension were found to be normal. The fundus was characteristic for polycythemia: hyperemic, cyanotic, and engorged vessels. The diagnosis of polycythemia was promptly confirmed by an examination of the blood (10.5 million red blood cells per c.ml.)

CASE 2

Mrs. C. B., aged 39 years, a Jewess, had never been too well since she left a German concentration camp a few years ago. She consulted an ophthalmologist because of redness of the eyes and tears. She also noticed that her eyes had become smaller. She said that her friends had asked her whether she had a cold or whether she had cried.

Examination of the eyes disclosed that the skin of the eyelids, as well as the skin of the face, was bluish-red. There was a drooping of both upper lids. The caruncle was red, swollen, and raised out of the inner lid angle. The conjunctiva of the lid and of the globe was reddish-blue and hyperemic but smooth and not hypertrophic. The cyanotic color of the conjunctiva was most distinct on the margins of the lids and also on the upper and lower conjunctival fornix. There was also a slight catarrhal secretion.

Examination of the fundus revealed typical cyanotic, engorged vessels. Otherwise the fundus examination was not contributory.

On the basis of these ophthalmologic findings the diagnosis of possible polycythemia was made. This was confirmed by blood examination which revealed 8.5 million red blood cells per c.ml.

DISCUSSION

In this second case, there was some secre-

tion in the eye. Normally, polycythemia is not accompanied by conjunctivitis; however, a traumatic conjunctivitis may sometimes follow polycythemia. If polycythemia persists for a prolonged time and the conjunctival vessels are engorged, causing irritation, a secretion may eventually result.

SUMMARY

The ophthalmologist has to think of polycythemia if a patient complains that his eyes have become smaller, that they look like they are full of tears. On the examination the lid margins are reddish-blue, slightly swollen, cyanotic; there is a droop of upper lids; the conjunctiva is blue and hyperemic, with engorged vessels, but smooth and not hypertrophic. The caruncle is slightly red and raised between the eyelids.

30 East 60th Street (22).

STREPTOMYCIN CAUSING RETROBULBAR OPTIC NEURITIS

CASE REPORT

PETER SYKOWSKI, M.D.
Schenectady, New York

History. E. T., a 45-year-old white housewife, was first seen in May, 1947, complaining of frontal cephalagia. The past history and family history were noncontributory.

The ocular examination then showed corrected vision to be: O.U., 20/20. Cycloplegic refraction was that of compound hyperopic astigmatism: O.D., +1.25D. sph. ⊂ −0.25D. cyl. ax. 15°; O.S., +1.25D. sph. ⊂ −0.25D. cyl. ax. 177°.

Biomicroscopy and ophthalmoscopy were normal. The tangent-screen visual field with a one-mm. white test object under reduced illumination was normal, no central scotomas being elicited.

She was next seen on August 5, 1947, complaining of marked blurred vision in both eyes. Twelve days previously streptomycin therapy (0.37 gm., every three hours) was instituted for a severe pyelitis that was resistant to previous sulfadiazine and penicillin therapy. During the ninth day of medication, blurriness in both eyes occurred simultaneously; on the 10th day, streptomycin was discontinued. Other than her renal condition, a medical survey was negative.

Corrected visual acuity was 20/70, O.U. The pupils were semidilated and reacted sluggishly. Biomicroscopic and ophthalmoscopic findings, as well as the cycloplegic refraction, remained unchanged.

The tangent-screen visual field with a one-mm. white test object at a distance of one meter under reduced illumination showed central scotomas of approximately three degrees in the right eye and four degrees in the left eye. The peripheral fields were full.

Course. Thiamine chloride (20 mg., three times daily) was prescribed. Six days after the discontinuance of streptomycin, corrected visual acuity was 20/50, O.U. Two and one-half weeks later it was 20/30 and the subjective blurring had disappeared completely. On December 10, 1947, the corrected vision became 20/20, O.U.; and the central scotomas were absent in the visual fields.

SUMMARY

The central nervous system, particularly the vestibular apparatus and the eighth nerve, is concerned most frequently in the clinical toxicity of streptomycin.

This paper reports a case of retrobulbar optic neuritis occurring during the course of streptomycin therapy.

1330 Union Street.

SOCIETY PROCEEDINGS

Edited by DONALD J. LYLE, M.D.

NEW YORK SOCIETY FOR CLINICAL OPHTHALMOLOGY

November 6, 1950

DR. SAMUEL GARTNER, *President*

DIPLOPIA IN CONCOMITANT STRABISMUS

DR. ADOLPH POSNER AND DR. ABRAHAM SCHLOSSMAN presented two cases to illustrate the problem of postoperative diplopia in strabismus.

Case 1. A 20-year-old woman had crossed diplopia following a slight surgical overcorrection of an alternating convergent strabismus. The diplopia was so annoying that she consented to a second surgical procedure which succeeded in overcoming the diplopia by producing a slight esotropia.

Case 2. A 31-year-old woman had had an alternating divergent strabismus since infancy. This was corrected surgically and, although her eyes were cosmetically straight, she experienced an homonymous diplopia as a result of an insignificant but measurable overcorrection (esotropia).

Comment. The diplopia in these and other similar cases which have come under observation is caused by surgical overcorrection which permits the false image to fall on a portion of the retina which had not attained the ability to suppress. A similar setup can be produced preoperatively by overcorrecting the deviation with prisms and often diplopia can thus be elicited. This should be a useful guide in prognosis. In such cases, especially in adults, one should aim at slightly undercorrecting the strabismus.

Suppression was shown to be an exaggeration of the normal physiologic phenomena of binocular vision, namely, retinal rivalry, ocular dominance, regional suppression, and fusion. These factors were discussed in relation to the more general concepts of Gestalt psychology. While alternation between the eyes with regard to figure and ground is the rule, the dominant eye tends to see the figure more constantly than the nondominant.

In monocular strabismus the difference between dominance and suppression becomes so extreme that there is no alternation between the eyes. Yet, the rudiments of normal binocular vision may still remain in the periphery of the retina.

One factor in this relative stability of peripheral fusion may be related to the phylogenetic development, in the sense that peripheral vision is more primitive than central vision. This feature may be utilized in orthoptic training by attempting to build up central binocular relationships within the framework of peripheral fusion.

Discussion. Dr. Adolph Posner said that it is safer to operate on a child because children adapt more easily to the new conditions when the eyes are straightened. In adults, the chief difficulty arises when there is normal retinal correspondence. In these cases, it is necessary to find out whether diplopia will develop after the operation.

In examining, Dr. Posner said he always tries to overcorrect the strabismus by prisms. If diplopia is found, one has to be wary. Presence of diplopia shows that there is incomplete suppression of one image. In children, it is difficult to overcorrect a large amount of strabismus with prisms.

If diplopia is elicited before operation, this does not necessarily indicate that there will be diplopia postoperatively. However, Dr. Posner suggested undercorrecting and also warning the patient or the patient's parents of the possible need for a second operation.

Discussion. Dr. Arthur Linksz agreed that postoperative diplopia will appear in patients with normal retinal correspondence. The so-

called group with anomalous retinal correspondence will never show diplopia.

Dr. Kestenbaum said that he was glad to see that the principles of Gestalt psychology were being applied to explain this phenomenon. In severe amblyopia ex anopsia (finger counting or hand movements) the temporal vision may be normal. Amblyopia occurs everywhere in the retina where the two eyes work together. Therefore, the diplopia after operation will occur in undercorrection as well as in overcorrection.

Dr. Lloyd asked whether the question does not depend on how good the macula of the squinting eye is.

Dr. Rollet said that he felt that the squint is nature's way of protecting the child against diplopia. In operating, you bring the eye back to its original position and the diplopia returns postoperatively. To eliminate this problem the child must be trained to eliminate the diplopia.

Dr. Posner replied to Dr. Kestenbaum, that he agreed that the whole retina suppresses. However, it is a question of the degree of suppression. The central part of the retina suppresses most; next is the part exposed to false images, and least is the part not exposed to false images. To Dr. Lloyd, he replied that in the two cases presented both patients had good vision in both eyes and, therefore, the maculas must have been good.

Divergence paralysis with increased intracranial pressure

Dr. Max Chamlin said that there is clinical evidence that a divergence center exists in the middle of the brain stem. Lesions in this area have produced divergence paralysis. Divergence paralysis is probably not so infrequent as supposed. Some cases may be passed off as atypical diplopia.

In the past, seven cases of brain tumor, verified by surgery or necropsy, have been reported as showing divergence paralysis. In all of them, there was evidence of a local lesion in the posterior fossa. They all showed evidence of increased intracranial pressure. The divergence paralysis disappeared with surgery in three of the cases in which surgery disposed of the papilledema.

Dr. Chamlin reported five cases, all with increased intracranial pressure and all with typical divergence paralysis. One case had a cerebellar tumor, two had subdural hematomas, one had serous meningitis, and one had a deep parietal lobe lesion.

Surgery effected a reduction of the increased intracranial pressure in all five cases, with disappearance of the divergence paralysis.

Since only one out of these five cases showed a local lesion in the posterior fossa, there were four cases that did not show any posterior fossa lesion. The factors common to all these cases were increased intracranial pressure and divergence paralysis, with a loss of the divergence paralysis following decompression. The same factors were true in the three cases in the literature herein reported.

It seems reasonable to conclude, therefore, that divergence paralysis may result from increased intracranial pressure, without the presence of any local pathologic process in the so-called divergence center.

Discussion. Dr. Kestenbaum said that the problem of divergence paralysis is a very complicated one. The clinical picture is as described. The diplopia increases as the patient looks off into the distance. The clinical occurrence of this condition is definitely established. There is, however, the question of an explanation for this condition. Possibly it is an atypical type of abducens paralysis. The question comes up of whether or not there is a divergence center. An anatomic divergence center must be found in order to prove its existence, otherwise it remains an assumption.

Dr. Pascal said that he agreed with Dr. Kestenbaum's views. He suggested that divergence may just be relaxation of convergence.

Dr. Linksz also agreed with Dr. Kestenbaum that there is no divergence center.

Dr. Chamlin replied that, in his paper, he was not seeking to prove or disprove the existence of a divergence center. It is possible that a small weakeness in both external recti is an early abducens paralysis. More variations in distance between the images would be expected under such a theory, and this was not found.

PARALYSIS OF OBLIQUE MUSCLES

DR. ERNEST A. W. SHEPPARD said that paralyses of vertically acting muscles present difficulties in differential diagnosis due to: (1) The duration of the paralysis and the amount of recovery; (2) secondary changes in the yoke and the antagonist; (3) underaction of the contralateral antagonist, so-called inhibitional palsy; (4) the fixing eye; (5) the fusion states; (6) paralysis of more than one muscle.

Late paralysis of the right superior oblique and of the left superior rectus have many factors in common: (1) Underaction of the paralyzed right superior oblique and left superior rectus; (2) overaction of the yoke muscles—left inferior rectus and right inferior oblique; (3) overaction of the antagonists—the left superior rectus and the right superior oblique; (4) ptosis—false and true.

Differential diagnosis depends to a large degree on the type of ptosis and the increase or decrease of the hypertropia when the head is tipped to the right or to the left shoulder respectively. Changes in the position of the head are evidence of the desire for fusion. They are not present when the attempt for binocular single vision is not made.

Movies of three patients were shown. In Case 1, there was an old paralysis of the right superior oblique, which had retained all the characteristics of recent paralysis. The head was tipped to the left shoulder. It rotated to the left and the chin was depressed.

Case 2 represented paralysis of the right superior oblique and the left inferior oblique. In this case, the pronounced increase in the right hypertropia when the head was tipped to the right shoulder was additive—that is, the hypertropia increases when the head is tipped to the right shoulder in paralysis of each muscle, but it is less pronounced in paralysis of the inferior oblique.

Case 3 showed paralysis of the right inferior rectus and of the right superior oblique.

Movies are valuable for record purposes, for teaching, and as an aid to differential diagnosis. They can be studied at leisure and in conjunction with other tests. Thus a hasty diagnosis need not be made.

Dr. Sheppard's fourth patient showed paralysis of the right inferior oblique. Recession of the left superior rectus was performed. The immediate postoperative subjective test (Maddox rod) showed overcorrection; whereas, the objective test (cover test) showed undercorrection. In this case the vertical fusion was strong and repeated tests were necessary before the diagnosis was made.

Bernard Kronenberg,
Recording Secretary.

COLLEGE OF PHYSICIANS OF PHILADELPHIA

SECTION ON OPHTHALMOLOGY

April 20, 1950

DR. WILFRED FRY, *chairman*

HUMAN INFECTION WITH THE NEWCASTLE VIRUS OF FOWLS

DR. ARTHUR H. KEENEY (by invitation) AND DR. MATTHEW C. HUNTER (by invitation): Newcastle disease or avian pneumoencephalitis was first recognized in America about 1941. Infected animals discharge the virus in their nasopharyngeal secretions, feces, and eggs. The disease has become a major problem in the chicken industry, and can be transmitted to humans.

Seven reports have been published covering 30 human infections characterized by an

acute granular conjunctivitis with preauricular adenitis, fever, headache, chills, and an invariable contact with sick poultry or isolated virus. Incubation ranges from a few hours to three days with all patients recovering in five to 14 days without sequela.

The case of M.C.H., who was splashed in the face with a chick embryo culture of Newcastle virus, was reported. Despite disinfecting precautions, the following morning he had an acute papillary conjunctivitis with scant secretions. Conjunctival smear showed many lymphocytes and culture was negative. He developed headache, backache, and fever followed by chills and epiphora.

The following day epithelial infiltrates and mild visual impairment appeared but definite improvement occurred on the third day. Preauricular adenitis developed on the fourth day, and conjunctival signs slowly cleared over 25 days.

Epithelial cells studied on the second and fifth days showed particles in the cytoplasm compatible with virus inclusions. There was a transient leukopoenia and lymphocytosis. Treatment with local aureomycin and penicillin appeared valueless; active virus was recovered from both eyes after this medication.

The Newcastle virus is capable of agglutinating erythrocytes, and antibody formation is demonstrated by hemagglutination inhibition and other laboratory procedures. In this case virus was recovered from both eyes and the blood stream. Serum antibody response followed an immune pattern similar to that of other virus diseases.

In differential diagnosis, the various types of acute catarrhal and acute follicular conjunctivitis must be considered.

Discussion. Dr. Wilfred Fry: My only connection with this case has been the opportunity to see the slides in which the occlusion bodies were seen. These inclusion bodies were as sharp as any I have seen. Dr. Gettes saw the clinical manifestations of this case, and I am going to call on him for discussion.

Dr. Bernard C. Gettes: By Dr. Kenney's statistics of proven cases, he demonstrates the occurrence of this disease in individuals exposed to chicks, and in laboratory workers.

In this case, it was not clinically possible to differentiate the disease from any ordinary acute papillary conjunctivitis. A significant occurrence was the patient's systemic reaction. All of us in our clinical practices have seen cases in which the individuals have volunteered the information that their eyes watered a bit, that they had some chills and fever, and that they were sick for a day or two with an upper respiratory infection. Very often, the patient insists that his conjunctivitis is part of his "cold."

Perhaps some of these individuals have this or a very similar type of infection. These cases recover in spite of treatment. In this patient, we tried aureomycin in one eye and penicillin locally in the other. Not only was the course of the disease unaltered, but the virus could still be seen as epithelial inclusion bodies even after antibiotic therapy.

The lesson we can learn from this case is to take greater advantage of the laboratory. Emphasis is also placed on examining epithelial scrapings because, in these cases, the smears were negative, but the inclusion bodies were seen in the scrapings. Lastly, emphasis should be placed on the fact that this condition is part of a systemic disease and is not solely an infection of the eye.

Dr. Eisenberg: I would just like to ask Dr. Keeney a question. Did you administer aureomycin or penicillin orally or systemically instead of just locally?

Dr. Arthur H. Keeney: In regard to Dr. Eisenberg's question of systemic medication, we did not employ this route because the total systemic pattern of the human disease had not been emphasized in previous case reports, and was not fully anticipated at the time of this patient's infection. The leukocyte response and viremia are not only original findings in this disease, but were somewhat surprising to us.

ACCOMMODATIVE CONVERGENCE

DR. EDWIN F. TAIT: In an individual who has good single binocular vision with ocular comfort, the accommodation which must be used for near fixation does not depend upon convergence, nor does the convergence required depend upon the use of accommodation.

Previous work has shown that the effective reflexes which control convergence in binocular vision are those which apportion the distribution of tonic reciprocal innervation to the extraocular muscles, and those fusional vergence mechanisms which supplant the tonic vergence in any other than the orthophoric condition.

When, however, the fusional vergence reflex is destroyed by fusional dissociation procedures, the convergence is left free to respond to effective stimuli other than those supplied by the fusional mechanisms. These effective stimuli may be the tonic innervation alone, or modifications of the tonic innervation introduced by either the use of accommodation or the proximity of the object.

The one exception to this situation is when the convergence due to accommodation is excessive and replaces, therefore, the basic tonic convergence reflex as that which must be modified by the fusional vergence mechanism.

Accommodative convergence may be defined as convergence which is induced by the presence of accommodative innervation when, by the withdrawal of fusional control, the convergence is left free to respond.

Discussion. Dr. William E. Krewson, 3rd: This presentation by Dr. Tait, covering careful and refined measurements on almost 5,000 subjects, spread over 14 years, represents the expenditure of a tremendous amount of energy. The magnitude of this work can only be appreciated when one stops to consider that not one, but many, muscle-balance estimations were required on each subject, for both near and distance, to say nothing of the many calculations necessary, as well as the statistical analysis of the results.

It is difficult to comment on this subject and, when the results are published, I feel that the paper will not only have to be read, but re-read, before its significance can be appreciated fully.

I can only mention a few points in Dr. Tait's work which impressed me most, merely to emphasize them:

First, a wide range of heterophoria, especially for the near point, can be present and patients still remain comfortable.

Second, the accommodation-convergence reflex is present, at least to some extent, in normal individuals of all ages, even in the late presbyopes.

Third, heterophoria at the near point is largely dependent, not only on the amount of accommodative convergence that is present, but also on the amplitude of the reflex that is exercised, while fusional vergence acts as a supplement when necessary for fixation.

Lastly, Dr. Tait suggests that we consider muscular anomalies in the light of the causative or initial stimuli, rather than as observed or resultant motor responses.

OCULAR MANIFESTATIONS OF MULTIPLE SCLEROSIS

DR. JOSEPH C. YASKIN, DR. ROBERT J. VERNLUND (by invitation), AND DR. EDMUND B. SPAETH: The ocular manifestations in 100 consecutive cases of multiple sclerosis were studied by the combined services of Ophthalmology and Neurology between the years of 1943 and 1950. Of these, 56 cases had ocular manifestations of multiple sclerosis.

Of the 100 cases, 57 were in women and 43 in men. The average age of the onset of symptoms was 28.6 years for women; 29.08, for men; at the time the diagnosis was made, it was 30.1 years for women; 36.8, for men.

Of these cases, 27 patients had ocular

For Dr. Tait's complete paper see the AMERICAN JOURNAL OF OPHTHALMOLOGY, 34:1093-1107 (Aug.) 1951.

manifestations as their earliest symptoms. These symptoms varied from such indefinite complaints as general blurring of vision, jumpiness of vision, double vision, gradual loss of vision, and difficulty in focusing.

Other manifestations of multiple sclerosis appeared subsequent to the initial symptoms at intervals varying from a few days to 14 years. Of the 100 patients, 73 presented other subjective neurologic manifestations.

The Bárány studies in these cases were of some help in indicating that an organic lesion was present either above or below the tentorium, although this test was negative in a large percentage of cases.

The electro-encephalogram, the routine laboratory procedures, and the gastric analysis were helpful only as negative findings. The spinal fluid studies were rather disappointing in this series of cases since only a small percent showed any significant changes. The encephalogram, although not diagnostic, may be suggestive in some cases of degenerative disease of the nervous system; it helps to rule out other structural diseases, such as brain tumor, arachnoiditis, and large areas of softening.

Despite the unsatisfactory state of present therapy of multiple sclerosis, an early diagnosis is desirable, at least from the standpoint of prognosis, and with the hope that in the near future a more satisfactory therapeutic approach may be achieved.

The ocular manifestations of multiple sclerosis are early prominent symptoms, and should be carefully evaluated for the purpose of an early diagnosis. At the same time, caution should be exercised not to rely too strongly on some symptoms as being pathognomonic of multiple sclerosis. These symptoms include retrobulbar neuritis, nystagmus, and less clearly defined complaints and findings.

It is particularly desirable to diagnose early those conditions which simulate multiple sclerosis, such as brain tumors, arachnoiditis, and so forth, which begin with ocular symptoms, and which are amenable to treatment before the patient becomes hopelessly blind or otherwise disabled.

Discussion. Dr. Joseph C. Yaskin: It seems to me that Dr. Vernlund has said pretty nearly enough in my behalf, but perhaps some of you would like to know why we reviewed the 100 cases of multiple sclerosis.

When a young lady developed an optic swelling in her second eye, her oculist called me from the northwestern part of the state wanting to know whether there was not some error in diagnosis. He stated, "I never saw a swollen disc in multiple sclerosis." I assured him that such a condition occurred. This single episode made me believe that it might be worth while to review this rather common disease.

Other reasons for reviewing the cases are not hard to remember. We often see advanced retrobulbar neuritis treated by ophthalmologists who do not even think of the presence of multiple sclerosis. I am quite sure this audience is thoroughly familiar with the etiologic relationship between multiple sclerosis and retrobulbar neuritis, but apparently there are a few oculists in Pennsylvania, and very likely other communities, that are not keenly aware of this association.

The third reason for presenting these cases is to call attention to the need for caution in differentiating conditions that are more amenable to treatment. It is true we do not have dozens of cases of brain tumors diagnosed as multiple sclerosis, but we have a reasonable number in which the eye signs are misleading, and perhaps a much larger number that are diagnosed as multiple sclerosis and turn out to be lesions other than those concerned with the ocular phenomenon. From this standpoint, we felt it would be worthwhile reviewing these cases, and I am quite sure that the men in this audience have some personal experiences which might be

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This paper was published in full in the AMERICAN JOURNAL OF OPHTHALMOLOGY, 34:687-697 (May) 1951.

of interest in connection with this presentation.

Dr. Glen C. Gibson: I think it is unnecessary for Dr. Yaskin to apologize for bringing this subject before us. There are many lessons to be learned, and many occasions in which we have to depend on the neurologist in these and other similar types of cases. My interest in multiple sclerosis first began when I was in Minnesota, and illustrates how it is possible for one to obtain an early and inaccurate impression about the incidence and causes of disease processes.

At that time, it was more or less routine to find at least one or two cases of acute multiple sclerosis every week in which the eye findings constituted the initial episode. These cases were usually found to have a unilateral central scotoma. It was our custom to refer these cases to the Neurologic Department, and we would anticipate that they would find confirmatory evidence of multiple sclerosis at the time the initial optic nerve lesion was active. They would find zone-one colloidal gold changes which were suggestive of the disease, together with slight or moderate increase in the cell count in the cerebrospinal fluid. We find relatively few of these cases in Philadelphia.

It has been pointed out that there is a peculiar geographic distribution of this disease, and this explains some of the apparent discrepancies that one encounters in the literature. This geographic irregularity of the condition is illustrated by the fact that, since coming to Philadelphia, I find just exactly the reverse situation as to the incidence of retrobulbar neuritis being due to multiple sclerosis.

At the present time, when we see a case of retrobulbar optic neuritis in Philadelphia, it is our impression that we will not find multiple sclerosis as an etiologic factor at the time the retrobulbar neuritis is active. The majority of our recent cases of retrobulbar neuritis have been idiopathic in origin. The neurologic and spinal-fluid findings are routinely negative. My experience in Minnesota was just the reverse of this.

I am particularly pleased that the authors have pointed out the variability of findings in the optic disc. One gets the impression from the literature that temporal pallor is very common and also pathognomonic of multiple sclerosis when just the reverse is the case. They pointed out that one may find complete pallor, and may also have nasal pallor, and, what is more important, one can frequently find the fundi negative.

I should like to ask Dr. Yaskin if there is anything peculiar about the type of nystagmus in multiple sclerosis which makes him suspicious of that disease. Harris has described the type of nystagmus which he refers to as the ataxic type, in which there is a limitation of adduction of each eye. Thus, the movement is toward the nose, is incomplete, and there is more nystagmus of the opposite eye. This point is considered to be quite characteristic. I have not observed it, or more accurately have not searched for it.

I would also like to have Dr. Yaskin's opinion about the euphoria that exists in multiple sclerosis. It is quite characteristic that people with this disease have a disproportion between their mental attitude and the seriousness of their condition. They have a characteristic euphoria, and I would like to know if he has any concept of the mechanism of that aspect of the disease, and if he encounters it in other conditions.

I have enjoyed this paper very much, and would like to thank the authors again for the opportunity of hearing of their experiences.

Dr. Joseph C. Yaskin: Dr. Gibson raised a lot of interesting questions. To begin with, when I was an intern at the Philadelphia General Hospital, 1914 to 1916, we had very few cases of multiple sclerosis, and it wasn't due to faulty diagnosis on the part of Dr. Spiller, Dr. Weisenberg, and others. There were just fewer cases in that part of the country at that time.

When I reached Europe in 1927 and 1928, there were special wards for multiple scle-

rosis in Central Europe, Austria, Germany, France, Italy, and Great Britain. Even within the last two decades there has been a very marked increase in multiple sclerosis, and it is not unusual for a busy neurologist to see two or three brand new cases a week or even more. I had the misfortune of seeing three young college girls in one week last winter. There was a time when we thought that Negroes were immune to multiple sclerosis, but this is false, as was borne out by very careful statistical study in Baltimore within recent years.

Idiopathic retrobulbar neuritis, as Dr. Gibson undoubtedly knows, points to a very poor diagnosis. I do not have any doubt that retrobulbar neuritis may, on rare occasions, be due to invasion from the paranasal sinuses. Mueller believed that the sinus signs of retrobulbar neuritis might be a causative factor of multiple sclerosis later in life. Well, of course, we know that is not true.

Nor do I have any doubt that there may be multiple sclerosis due to other toxic factors, but unfortunately, in our experience, all we have to do is wait long enough, and the retrobulbar neuritis of today will be multiple sclerosis next month, or five years from now. It nearly always turns out to be multiple sclerosis.

I am not familiar with any special nystagmus that I can identify as due to multiple sclerosis. Dr. Harris talks of ataxia, I suppose he is trying to bring the nystagmus in correlation with a tremor, and other cerebellar disturbances that are observed in various parts of the body.

It is quite possible that he who puts his mind on the subject over a long period of time may notice special difficulties. Insofar as I am concerned, in evaluating nystagmus, the first thing I want to do is make sure that I have a real nystagmus, and not just an occasional jerk due to position or fatigue, or to barbiturates or other toxins.

I want to be sure I am not dealing with congenital ocular nystagmus, which is very easy to exclude. I want to be certain I do not have a disease of the internal ear.

Having ruled out these conditions, I determine what type of nystagmus I have, whether it is horizontal or vertical, and then try to correlate it with some intracranial condition which may exist.

I think it is pretty safe to state that neurologic nystagmus—nystagmus not due to involvement of labyrinth or ocular causes, fixation and myopia and so forth—is almost always due to a lesion below the tentorium. That knowledge is extremely useful in everyday practice, because it so happens that, excepting the blastomas of early life, a good many tumors below the tentorium are amenable to satisfactory surgery if they are diagnosed early enough. Of course if you wait until you get obstruction of the brain stem, surgery is not going to do any good.

If one can diagnose multiple sclerosis before evidence of increased intracranial pressure and before major damage to the brain stem, the patients get many years of usefulness and comfort.

The emotional state in the multiple sclerotic is of interest. The incidence of insanity is no greater among patients with multiple sclerosis than it is among the population in general. We assume that four out of 100 people develop a psychosis sooner or later. The percentage is about the same in multiple sclerosis. It is true that the majority of people with multiple sclerosis have a tendency to euphoria. We do not know why.

There can be no doubt that some of them have plaques in the temporal lobe, and perhaps in the region close to, though not necessarily involving, the diencephalon.

It is also well known that very early in the disease individuals with multiple sclerosis may show so much affectation that their condition is diagnosed as hysteria. We feel that they are putting on an act, and each one of us have written a report that we wish we had never written, stating that this is undoubtedly a case of hysteria—only to discover, months or years later, the presence of everything in the book: optic atrophy, trem-

ors, Babinski sign, and so forth. Emotional disturbances are common and euphoria is fairly common, but not by any means constant.

The emotional state in any organic disease of the brain depends very largely on the personality of the individual before he had the disease, and while it is true that, in multiple sclerosis, euphoria is common, we encounter all sorts of reactions. We encounter tension states, paranoid states, emotional depression, suicidal attempts, and so forth.

Nevertheless, those of us who have seen many cases of multiple sclerosis suspect this disease by the physiognomy. Nobody will make a diagnosis of multiple sclerosis but, as one goes through the ward and looks at that young person, somewhere between the age of 20 and 35 years, and as he or she looks at you, you have a feeling that there is probably a case of multiple sclerosis.

It is one of those things which is difficult to describe, just as when you go through the ward you say—there is a case of paresis, or there is a case of melancholia. One cannot give it any diagnostic value, but, when those patients walk into the office with that certain expression, I suspect multiple sclerosis from the start.

Lastly, ophthalmic problems in general should be more closely incorporated in our study of neurology. I rather fear that a great many neurologists do not keep up with the eye work, and it is quite possible that some ophthalmologists tend to deviate from the interest of neurology, which may be useful in some of their neuro-ophthalmic cases.

M. Luther Kauffman,
Clerk.

OPHTHALMOLOGICAL SOCIETY OF MADRID

May 26, 1950

Ocular pemphigus

Dr. Mario Esteban presented an 11-year-old girl who, since the age of seven years, had been developing vesicles on the skin and mucous membranes. She had been subjected to all kinds of treatment in the Hospital of San Juan de Dios (arsenicals, bismuth, penicillin), without any results. More and more vesicles kept on following one another. There was a positive Wassermann reaction two years previously. However, there are no signs of hereditary lues. The parents are healthy, have a negative Wassermann, and give no history of a syphilitic infection.

In the eyes one observes a process of sclerosis of the conjunctiva, with retraction, the condition becoming more marked with time. The superior and inferior fornices in both eyes tend to disappear and are intercepted by numerous bands of symblepharon.

The process of sclerosis extends to the cornea, having invaded the latter to a large extent in the form of tonguelike projections. In several places, the conjunctiva extends over the cornea forming a bridge attaching the cornea to the upper tarsal conjunctiva, as a result of which the eye movements are very much restricted with resulting diplopia.

Clinically, the predominant picture is that of sclerosis and retraction. However, biomicroscopy shows several small, erupted vesicles near the limbus.

Pemphigus has an unfavorable prognosis. A halibut salve was prescribed to resist the sclerosing process and the tendency to xerosis.

The similarity of the anatomic and pathologic lesions of pemphigus, the etiology of which is still unknown, to the lesions of herpes and other diseases caused by a neurodermatologic virus in which affections aureomycin seems efficacious led me to try the product, although the results were perhaps no better than with any of the other medications used.

Surgical treatment does not give good results. Cicatrization after removal of some of the tissue only leads to more retraction.

However, in this case surgical intervention seemed indicated to cut the bridge connecting

the upper part of the cornea with the tarsus in the right eye, as this caused limitation of movement and diplopia. Grafts of skin and mucosa to replace the conjunctiva, as well as corneal grafts, do not help much as it has been shown that the grafts soon succumb to the same disease process, developing vesicles, followed by sclerosis.

Filariasis

Dr. Mario Esteban presented two cases of filariasis in which he succeeded in extracting the parasites. One specimen was female, the other male. In both patients, the presence of other adult parasites was confirmed, as was the presence of diurnal microfilarias in the blood, at least two embryos per drop, rising in some to eight and even more in others.

Although one can extract the various adult parasites, this does not solve the therapeutic problem, since in all cases the blood is already invaded by the microfilarias.

There is now an efficient filaricide, recently introduced under the name of hetrazan (chlorhydrate of diethyl-4-methyl piperazine), whose effectiveness was shown on experimental animals and also on humans.

Discussion. Dr. Carreras Matas asked about the mode of administration and the dosage of hetrazan.

Dr. Mario Esteban said that the medicine is given by mouth, the dose is 0.5 to 2.0 mg. per kilo of body weight, repeated three times daily, for three or four weeks. The Lederle laboratories supplies it in compressed tablets of 50 mg. each. The dose for an adult is one tablet three times a day, preferably after meals, or a total of 150 mg. daily.

Atrophy of optic papillas

Dr. Marin Amat presented a paper on the total atrophy of both optic papillas following large hemorrhages. He described the three kinds of visual disturbances which may be caused by extensive hemorrhages and which are due to ischemia, to a hemorrhagic constitution, or to general debility which can follow such hemorrhages.

The case presented belonged to the first category, that is, to an ischemic condition of the retina. A 51-year-old man suffering from stomach ulcers, within a period of 11 hours suffered four extensive gastric hemorrhages and one intestinal hemorrhage. Nine days later he showed a diminution of vision in his left eye, and total loss of vision 24 hours later. The same thing happened in the same way to the right eye the following day.

When the patient was examined about six weeks later he showed amaurosis with total atrophy of the papilla in both eyes. The retinal arteries were threadlike; the veins, thin; the optic disc, a mother-of-pearl white, the edges slightly blurred. There was a cloudiness of the fundus at the posterior pole of the eye as at the time when the sudden amaurosis made its appearance.

On the basis of this case and another seen earlier, Dr. Marin Amat discussed the etiology, age, sex, and derangements of the visual fields in cases of amblyopia, as well as the prognosis of the amaurosis which follows a large loss of blood, or small and often-repeated losses, mentioning also the bearing which the previous health of the patient has on these consequences.

Joseph I. Pascal,
Translator.

AMERICAN JOURNAL OF OPHTHALMOLOGY

Published Monthly by the Ophthalmic Publishing Company

THE VETERANS ADMINISTRATION PROGRAM FOR THE TRAINING OF THE BLINDED SERVICE MAN

For the first time in the history of our country, our government is prepared ahead of time to take care of the early and proper training of the newly blinded soldier or sailor.

In World War I, the problem was turned over to the Surgeon General of the Army who established General Hospital No. 7 on an estate near Baltimore for the purpose of rehabilitation of the blinded soldier. The first patient was admitted in April, 1919, six months after the termination of hostilities.

On May 25, 1919, the Army released the hospital to the Red Cross and it became known as the Evergreen School. It did good work. On January 1, 1922, the newly established Veterans Bureau took over and continued to operate the school until June, 1925, when it was finally closed up.

The history of this venture has been excellently described by Alan C. Woods in the JOURNAL (26:1011, 1943). Woods estimated

that about 400 soldiers and students passed through Evergreen during its entire career.

In August, 1942, Secretary of War Stimson became interested in the problem of what to do about the newly blinded service man, undoubtedly stimulated by a visit to him by Sir Ian Fraser, M.P., the director of the famous St. Dunstan's in England, who generously offered to extend the facilities of his institution to include the United States forces in England.

Secretary Stimson requested the chief surgeon in the European Theater of Operations, Maj. Gen. Paul R. Hawley, to look into the matter. In October, 1942, this was done and a report was sent back to Washington, outlining the fine work accomplished by St. Dunstan's and recommending that the newly blinded soldier in the E.T.O. be sent to St. Dunstan's, at least until the United States had established a comparable training center.

In the fall of 1943, as a result of a conference between the Army, Navy, Public Health, and Veterans Administration, an executive order was issued by the President of the United States requiring the Army to establish training centers to which the war-blinded service man, regardless of his branch of service, was to be sent.

In compliance, the Army established such centers in the Valley Forge and Letterman General Hospitals, and later in Dibble General Hospital. The Navy withdrew from the plan and established its own center in the Philadelphia Naval Hospital.

In June, 1944, Old Farms Convalescent Hospital at Avon, Connecticut, was opened. Its purpose was to provide a course of training to the blinded soldier who had completed his definitive medical and surgical care and early training at Valley Forge or Dibble General Hospitals.

The magnificent work done at these institutions is too well known to require comment. Approximately 1,400 veterans, blinded during hostilities in World War II, require no treatment whatsoever in V. A. hospitals because of this successful program. These trained blind are leading useful and, for the most part, happy lives, as a visit to the convention of the Blind Veterans Association will attest.

This success is in marked contrast to the fate of a large number of World War I veterans who still are to be found in V. A. hospitals, for the most part long past the possibility of successful rehabilitation, although efforts along these lines are continuously being made by the Physical Medicine Rehabilitation Service of the Veterans Administration.

Following the termination of the Army and Navy program on the cessation of hostilities, the Veterans Administration, chiefly through the efforts of its then chief medical director, General Hawley, established the Central Blind Section of the Physical Medicine Rehabilitation Service, at the V. A. Hospital at Hines, Illinois.

General Hawley's successor, Paul Magnuson, in a foreword to a V. A. pamphlet (10-32) of February, 1950, said: "The Hines unit is small in terms of the number of patients that may be treated at one time. However, it is unique in that it uncovers and develops the residual potential aptitudes and ability of the blinded veteran and enkindles in him a motivation that leads to the accomplishment of physical and mental tasks which constitute for him, as an individual, a high standard of living."

At the time of its establishment, the Central Unit, whose chief is Russell C. Williams, himself a blinded veteran, served a small group of veterans losing their sight during the postwar period due to injuries that occurred in military (including naval) service.

Its course of training is usually 18 weeks, consisting of environmental therapy in which the patient learns how to deal with the effects of blindness, and continues, with increasing evolutionary skills, the techniques learned so arduously in World War II. It is not a vocational school.

Thus, it was, when the Korean venture exploded, our government had a unit already established and operating successfully for the early training of the newly blinded warrior. The unit has had to expand in size, unfortunately, but is entirely capable of further expanding should the exigency arise.

People such as Mr. Warren Bledsoe, consultant to the V. A., Miss Katherine Gruber, assistant executive director of the American Foundation for the Blind, Dr. R. E. Hoover and Mr. Harry Spar, of the Brooklyn Industrial Home for the Blind, and many others, who have had great experience with the problem of training the blind, all agree that the earlier the training is started after the catastrophe, the better the result.

Because of many difficulties, some administrative, some psychologic, others personal both from the viewpoint of the patient and of the medical officer in charge of the case, there has been some delay in compliance with the executive order of early transfer of these cases from army, air-force, and naval hospitals to the Central Unit. The red tape, however, is being rapidly eliminated, and the other factors, more readily understood as the value of this training becomes manifest both to the patient and to his medical officer, are becoming less and less significant.

The result is that today the newly blinded soldier, air-force man, and sailor are, for the most part, being quickly evacuated from the battlefield, rapidly passed through the military hospitals and into the Central Unit where, along with definitive medical and surgical care, professional understanding of the problem and expert training of these unfortunates can be given early before hopelessness sets in.

The Central Unit at Hines, endorsed by the Department of Defense, the Army, Navy, and Air-Force Surgeon Generals and wholeheartedly supported by the new chief medical director of the V. A., Admiral Joel Boone, begins a new and important chapter in the evolution of the rehabilitation of the newly war-blinded, and is a cause for optimism for the future. Derrick Vail.

BOWMAN MEMORIAL FUND

The following note has been received from the Venerable C. E. Lambert, Archdeacon of Hampstead, Rector of Saint James's Church, Piccadilly:

I have just heard from Sir Stewart Duke-Elder of the splendid gift that has been collected toward the Restoration Fund of the Church of St. James's, Piccadilly. I cannot adequately express my appreciation of the generosity which has prompted this gracious act. I welcome the suggestion that a small bronze plaque should be placed in the neighbourhood of the Memorial Tablet to Sir William Bowman, recording American appreciation of his services to the science of ophthalmology.

Sir Stewart Duke-Elder has handed to me the cheque for £574, and I am sure that on his coming visit to the United States he will convey by word of mouth our sincere and warm gratitude to those who have so kindly contributed.

I hope it may be possible to earmark this generous contribution for some particular object in connection with the refurnishing of the Church.

I note, with additional gratitude, that the expenses of the preparation and placement of the bronze plaque will be borne by the AMERICAN JOURNAL OF OPHTHALMOLOGY.

Yours sincerely and gratefully,
C. E. Lambert.

CORRESPONDENCE

LENTICULAR INTUMESCENCE

Editor,
American Journal of Ophthalmology:

As noted in the editorial by Derrick Vail in the JOURNAL of July, 1951, the paper on the cation changes in the lens by J. E. Harris

and L. B. Gehrsitz, published in the JOURNAL of May (Part 2), 1951, received the prize award for the 1950 session of the Association for Research in Ophthalmology. The authors demonstrated for the first time that the loss of potassium and the gain in sodium, so characteristic of the cataractous lens, occurs likewise in vitro when a normal rabbit lens immersed in Tyrode's solution is subjected to refrigeration, deletion of calcium, and diverse metabolic poisons.

Gifford, Lebensohn, and Puntenny (Arch. Ophth., 8:414, 1932) have shown by micro-Kjeldahl determinations of the dialysates under these various conditions that the nitrogen loss is increased over that of the controls. The latter figure for fresh normal rabbit lenses immersed in Ringer's solution at room temperature averaged the significant amount of 0.114 mg. N or 0.684 mg. protein per two-hour period.

Had the authors been less preoccupied by the idea of an active transfer of cations and had correlated the ionic shift with the nitrogen loss, they would have noted that whatever increased the ionic shift, such as refrigeration, likewise increased the nitrogen loss. The futility of attempting to reverse such an irreversible change by raising the temperature would then have been anticipated.

In these experiments a dying lens is observed and, as in cataract, all the biochemical deviations from the lens in health merely reflect processes involving or ensuing from autolysis. In studies of the water and mineral metabolism in the normal and cataractous lens (Am. J. Ophth., 16:1062, 1933; Arch. Ophth., 15:217, 1936) I pointed out that in cataract the potassium deficiency is but the inevitable result of protein loss and that the sequential increase of sodium simply balances subsequent requirements of osmotic equilibrium.

A characteristic of both intumescent cataract and lenses immersed in Tyrode's or Ringer's solution is the formation of vacuoles between the cells, the accumulation of water beneath the capsule, and water-splitting of the sutures. The autolytic breakdown of the protein chains causes a disruption of the normal balance between osmosis and imbibition in that an increased osmosis accompanies a lessening of imbibitional capacity. Consequently more water is drawn into the lens than the altered lens protein can absorb.

The extent of the ionic shift is related to the quantity of intumescence since these phenomena are direct and indirect consequences of autolysis respectively. In the authors' assumption that "far from being secondary to the formation of a cataract, as has been previously thought, the shift in cation content has a causative relationship to lenticular intumescence," they fly from solid physicochemical data into ethereal metaphysical conjecture—and, bluntly, the cart is placed before the horse.

(*Signed*) James E. Lebensohn,
Chicago, Illinois

DR. HARRIS' REPLY

Editor,
American Journal of Ophthalmology:

I wish to thank Dr. Lebensohn for his comments on our paper. In his letter he advances the view that the potassium loss we measured under various conditions was due to autolysis of protein. There are certain aspects of this problem which were not discussed in our publication nor in Dr. Lebensohn's letter. These, I should like to touch on, briefly.

First, our figures for loss of potassium are of a different magnitude from Dr. Lebensohn's for loss of protein. Accepting for the moment the data he quoted in his letter as a measure of protein hydrolysis, one can calculate that slightly less than two percent of the protein of a 300 mg. rabbit lens would be hydrolyzed in six hours at room temperature. The rate of hydrolysis at refrigerator temperatures should certainly

be no higher. Yet, we observed that the rabbit lens lost in excess of 25 percent of its total potassium at refrigerator temperatures over a six-hour period. A comparison of the figures hardly justifies Dr. Lebensohn's conclusion that "The extent of the ionic shift . . . (is a) direct consequence of autolysis."

Second, the rate of autolysis of lens proteins has been shown by others to be extremely slow. This was demonstrated by Krause (Arch. Ophth., 10:631-639, 1933) who measured serial changes in the lens protein, peptone nitrogen, and nonprotein nitrogen and noted no appreciable hydrolysis of protein over several days at 37°C. when the reaction of the mixture was approximately in the physiologic pH range. A measurable autolysis, proceeding over several days, was noted at pH 7.0 and below. The experiments of Sauermann (Am. J. Ophth., 16:985-993, 1933) are in substantial agreement. (Our experiments were all conducted at the physiologic pH range and were terminated in from 4 to 20 hours. During this time period as much as 75 to 80 percent of the total potassium was observed to diffuse from lens.)

The figures which Dr. Lebensohn quotes represent the total nitrogen of a Ringer's solution in which the lens had been placed for two hours. Until proved otherwise, it must be concluded that the authors were simply leaching existing diffusible nitrogen from the lens.

Third, there is no reason to believe that our experimental conditions would be associated with an increased protein autolysis. Our results were based on a comparison of the potassium loss (and sodium gain) of the two lenses from the same animal; one, the control, was kept at 37°C. in Tyrode's solution, while its mate was subjected to various experimental procedures such as refrigeration, treatment with various metabolic poisons, or deprivation of glucose.

In every instance a marked shift of cations occurred in the experimental as compared to the control lens. For example, there was a marked shift of cations at refrigerator temperatures but not at 37°C. I know of no data which indicate that autolysis of lens protein proceeds at a more rapid rate at refrigerator than at body temperatures. Indeed, such is contrary to the usual laboratory experience and, to our knowledge, of the kinetics of enzymatic and chemical reactions.

Dealing with the intact cell may introduce other variables, but certainly the burden of proof must rest with those who would contend otherwise.

Last, but by no means least, Dr. Lebensohn's theory will not account for the high potassium and low sodium normally observed. Certainly, any theory purporting to explain a change from the normal is of little value if it cannot be extended to the maintenance of the normal. Studies with radioactive isotopes have proved beyond doubt that the cells of most tissues, including the lens, exchange potassium and sodium with their fluid environment. The limiting cellular membranes are thus normally permeable to those cations.

To account for the normal cation distribution the concept of an active transfer of at least one of these ions has been developed. (See Ussing: Physiol. Rev., 29:127, 1949.) Our experiments and conclusions adhere to this concept.

Dr. Lebensohn, however, must conclude that the normal ratio (high potassium and low sodium) of the cell results from a preferential binding of potassium to the cell protein. This theory has been advanced from time to time only to be abandoned, since it can be shown that a large fraction of the potassium of the cell is diffusible and, even more important, proteins do not link to potassium to the exclusion of sodium.

I think it unnecessary to amplify our own concept. This has been referred to and is undertaken in our original publication. However, there are two other points in Dr. Lebensohn's letter which deserve comment.

One concerns our failure to anticipate the "futility of attempting to reverse such an irreversible change by raising the temperature." (Dr. Lebensohn is here referring to our attempts to drive potassium back into and sodium out of the refrigerated lens by placing it at 37°C.)

I cannot share Dr. Lebensohn's pessimism, perhaps because I was able to demonstrate just such a reversal in the human erythrocyte (Harris: J. Biol. Chem., **141**: 579, 1941). A reversible potassium shift induced by cold has been demonstrated in the retina (Terner, Eggleston, and Krebs: Biochem. J. **47**:139, 1950).

In our original investigations we were not greatly concerned with this particular problem and did not exploit the possibilities to the fullest. We have undertaken such experiments now and hope to provide the answer, one way or the other, in the near future.

The other comment concerns the last paragraph of Dr. Lebensohn's letter in which he takes issue with our explanation of intumescence. As we pointed out in our paper, the relationship of the cation shift to the intumescence is through the osmotic pressure of the proteins. If we could speak of biologic axioms, certainly one axiom would be that a cell will swell under the influence of the Donnan osmotic pressure when its membrane becomes freely permeable to ionic or other constituents of the medium, in the absence of some active compensatory force.

While we applied this concept to the lens, it was not original with us (see van Slyke, Wu, and McLean, J. Biol. Chem., **56**:765, 1923). We did not contend, nor do we now, that it is the only factor, nor necessarily the primary one, in the production of lenticular intumescence. Our choice of the adjective "a" was purposive.

Our facts, like Dr. Lebensohn's, are sound. Our concepts, like his, may not stand the test of time. But this does no great harm. To borrow from an oft-quoted phrase, so long as the data are correct, faulty interpretation is not necessarily unhealthy since it affords one's contemporaries the pleasure of proving him wrong.

(*Signed*) John E. Harris,
Portland, Oregon.

BOOK REVIEWS

INTERNAL DISEASES OF THE EYE AND AN ATLAS OF OPHTHALMOSCOPY. By Manuel Uribe Troncoso, M.D. Philadelphia, F. A. Davis Company, 1950, edition 2. 684 pages, 189 illustrations, 92 color plates. Price: Not listed.

The appearance of the second edition of a book attests sufficiently to its excellence that a reviewer need not come breathlessly to deliver himself of his opinion to the waiting world. I will, therefore, describe the book in the hope that I may be of service to the emergent ophthalmologist to whom this edition will be a welcome new discovery.

The internal diseases of the eye are, in general, those diseases which the examiner recognizes with the ophthalmoscope though he by no means gets a complete understanding of them by ophthalmoscopy alone. The guiding principle in the description of the diseases of these tissues—the choroid, the retina, and the optic nerve—is the understanding of them in terms of altered structure and function. The signs and symptoms, the ophthalmoscopic findings, and the charts of visual fields in each disease are clearly derived from a knowledge of the pathologic anatomy and physiology of the tissues that are involved.

The important ophthalmoscopes are described, not only the hand ophthalmoscopes used universally but binocular instruments as well, and the contact glass with which the fundus may be studied in the focal illumination of the slitlamp. The methods of using the ophthalmoscope are given in detail and the underlying optical principles are made clear. The important but unduly neglected indirect method is properly empha-

sized. The units which make up the picture of the fundus are discussed and it is shown how each detail of the minute anatomy of the structures of the fundus plays its part in the architecture of these ophthalmoscopic signs.

The equipment for field taking and the methods of using it are listed. The underlying principles of physiologic optics and topography of the nervous structures whose defects are made accessible by a study of the field are made the basis of interpretation of the findings.

The remaining chapters are an orderly account of the clinical manifestations of the developmental anomalies and diseases of the choroid, retina, and optic nerve. The author's vast experience and judgment are displayed in that no detail is omitted which adds in any way to a real understanding of a disease and nothing is included for the sake of mere pedantic completeness. Despite the enormous material that is covered in less than 700 pages the data are ever perspicuous and the exposition is so well arranged that the subject seems astonishingly simple.

The well-known diseases are as extensively exposed as if they were newly acquired territory, as indeed they are to the student, and many new entities whose nature is still the subject of study and controversy are discussed with skill and judgment.

The illustrations are clear and informative. Each is selected to clarify a detail that is described in the text and not merely to decorate a page. The color plates are beautiful. Most of them are excellent reproductions of colored drawings and a few of Kodachrome photographs of the fundus. It is a pity that several are poorly printed.

F. H. Haessler.

BULLETIN OF THE GREEK OPHTHALMOLOGICAL SOCIETY. Athens, Greece. Volume 17, Parts 2 and 3, October-December, 1949.

In Part 2, B. Tsopelas tells of the therapeutic use of radon and beta radiation as observed during his recent visit to the United States.

C. Chorèmis and T. Joannides report on their studies made of the eyes of children affected with tuberculous meningitis and generalized miliary tuberculosis and treated with streptomycin.

P. Dededimos discusses some types of deep conjunctivitis, characterized by diffuse hyperemia of the bulbar conjunctiva due to dilatation of the episcleral vessels and occurring in rheumatoid arthritis and various infectious diseases.

E. Hart and T. Dimitriou report on their treatment of vernal catarrh with roentgen radiation of the spleen. This method does not affect a permanent cure but nevertheless enables the patient to pass the summer months without troublesome ocular symptoms. The authors took their cue from Stephan, who showed that radiation of the spleen increases the coagulability of the blood, but are unable as yet to offer a satisfactory explanation of its mode of action in vernal conjunctivitis.

E. Theodorides and A. Photiades describe a case of complete ptosis following an insignificant injury and evidently of hysterical origin.

Prof. G. Cosmetatos tells of operative and postoperative complications experienced in his many years of cataract surgery, and S. Spyratos reports on the 56th meeting of the French Ophthalmological Society in Paris in 1949.

Part 3 is given over to the society's annual scientific review of some important aspect of ophthalmology. In 1949, the review was done by B. Adamantiadis on present-day conceptions regarding the pathogenesis of glaucoma.

His survey leads to the conclusion that primary glaucoma is really a group of unrelated ocular diseases which, for the present, cannot be differentiated sharply or classified. The etiology must be sought in various factors, nervous, endocrine, and

vascular, which may operate singly or together.

Glaucoma and ocular hypertension are not one and the same thing. Either may occur without the other. The term "glaucoma" should be used with particular reference to the changes in the optic disc and in the visual fields.

True glaucomatous excavation of the disc may occur without hypertension, and the author reports three cases of prolonged hypertension unaccompanied by loss of vision or field. Cases are well known in which an operation permanently cures the hypertension but nevertheless the glaucoma continues to progress until the eye is blind.

Schnabel's caverns are undoubtedly due to vascular lesions and must be recognized as an important factor in the development of glaucomatous atrophy of the optic nerve, but the role of the hypertension itself is also admitted in this regard.

The text of the *Bulletin* is in Greek but, at the end of each article, a summary is given in French. Harry K. Messenger.

CURRENT THERAPY, 1951. Edited by Howard F. Conn, M.D. Philadelphia, W. B. Saunders Company, 1951. 699 pages. Containing a roster of drugs, dosages, and conversion factors tables for making percentage solutions, and an index. Price: $10.00.

Current Therapy, 1950 won a wide following and a deserved success. The present volume under the direction of its able editor utilizes the services of 12 consulting editors and 275 contributors of whom 49 are new. The contributors have been carefully selected from among the outstanding teachers and practitioners of this country who are authorities in their respective fields. The descriptions of their present methods of treating the disease are brief but exact, and superb efforts have been successful in assuring the inclusion of the latest standard treatments.

The ophthalmologist worthy to be called physician will find much of interest and value in this book. The subjects covered are treatment of the infectious diseases, diseases of the respiratory system, cardiovascular system, diseases of the blood and spleen, of the digestive system, disorders of metabolism and nutrition, diseases of the endocrine system, of the urogenital tract, the venereal diseases, the allergic diseases, diseases of the skin, of the nervous system, of the locomotor system, obstetric and gynecologic conditions, and diseases due to physical and chemical agents.

Dr. Conn's preface states: "It is recognized that present-day treatment is a summation of the work of many physicians to whom credit is hereby given. It will be noted that in these methods, obsolete procedures are rarely mentioned and that methods not fully tested are so designated."

There is very little pertaining to the eye itself in this volume, which obviously is designed for the general practitioner. It is notorious how the general practitioner shies away from treating diseases and injuries of the eye, yet it seems to the reviewer that there is very much that a general practitioner can do in his daily practice to diagnose and treat many ocular conditions. A small section devoted to ophthalmology therefore would be a proper addition to a fine and useful work.

Derrick Vail.

ABSTRACT DEPARTMENT

EDITED BY DR. F. HERBERT HAESSLER

Abstracts are classified under the divisions listed below. It must be remembered that any given paper may belong to several divisions of ophthalmology, although here it is mentioned only in one. Not all of the headings will necessarily be found in any one issue of the Journal.

CLASSIFICATION

1. Anatomy, embryology, and comparative ophthalmology
2. General pathology, bacteriology, immunology
3. Vegetative physiology, biochemistry, pharmacology, toxicology
4. Physiologic optics, refraction, color vision
5. Diagnosis and therapy
6. Ocular motility
7. Conjunctiva, cornea, sclera
8. Uvea, sympathetic disease, aqueous
9. Glaucoma and ocular tension
10. Crystalline lens
11. Retina and vitreous
12. Optic nerve and chiasm
13. Neuro-ophthalmology
14. Eyeball, orbit, sinuses
15. Eyelids, lacrimal apparatus
16. Tumors
17. Injuries
18. Systemic disease and parasites
19. Congenital deformities, heredity
20. Hygiene, sociology, education, and history

1

ANATOMY, EMBRYOLOGY, AND COMPARATIVE OPHTHALMOLOGY

Ashton, Norman. **Anatomical study of Schlemm's canal and aqueous veins by means of neoprene casts.** Brit. J. Ophth. **35**:291-303, May, 1951.

This is the preliminary report of a new technique devised to show the anatomy of Schlemm's canal, its related vessels and the aqueous veins. Neoprene latex was first introduced for renal vascular studies and was used here very successfully; solid, colored molds of the canal and of its vessels and veins were produced. The apparatus and the technique are described and illustrated in detail. Enucleated or fresh postmortem eyes were used on which aqueous veins had previously been identified and marked with a ligature. The section of the eye anterior to the limbus was removed and the canal irrigated for several hours to eliminate all blood. It was then filled under pressure with colored neoprene; the rest of the eye tissue was dissolved by pepsin and trypsin. The cast is made permanent with gelatin and formalin vapor. Four eyes were prepared and studied. Two of the aqueous veins were seen to rise directly from the canal by a hook-shaped origin, the others were connected directly to the canal by anastomotic branches between the superficial and deep scleral plexus. All the aqueous veins were of the striated or laminated variety. Morris Kaplan.

Zander, E., and Weddell, G. **Observations on the innervation of the cornea.** J. Anat. **85**:68-99, Jan., 1951.

Between 61 and 68 nerve bundles enter the cornea, half of which contain between 15 and 30 axons, the remainder less. Episcleral bundles join deep bundles to form the episcleral pericorneal plexus from which they arise and pass into the superficial layers of the substantia propria. The subconjunctival fibers are small, deep and are in close relation to the blood vessels. The scleral fibers enter the cornea in a varied manner. No myelinated fibers extend more than two mm. from the limbus. Fibers enter the cornea in a radial manner. The nerve fibers remain in the same layer of the cornea. Each daughter axon is situated in a different layer of the substantia propria. The cornea still has a sense of touch after pain sense has been abolished. Irwin E. Gaynon.

2

GENERAL PATHOLOGY, BACTERIOLOGY, IMMUNOLOGY

Drozdowska, Stanislawa. **Penicillin sensitivity of bacterial strains grown from lid margin.** Klinika Oczna **19**:365-366, 1949.

There are some strains of bacteria which do not respond to penicillin. The author made cultures of the bacteria collected from the lid margin and tested them for penicillin sensitivity. In cases of penicillin-fast strains the author suggests the use of auto-vaccine.

Sylvan Brandon.

3

VEGETATIVE PHYSIOLOGY, BIOCHEMISTRY, PHARMACOLOGY, TOXICOLOGY

Azzolini, U., and Faldi, S. **Cataract elicited by administration of synthetic antihistaminic drugs.** Boll. d'ocul. **30**: 129-134, March, 1951.

Drugs of the amino-ethyl-aniline group —allergina, antadril, antistin, dimetina, fargan, neoantergan, pyribenzoxal and synopene—were administered to guinea pigs, intraperitoneally, subconjunctivally, and by instillation into the conjunctival sac. Subconjunctival injection of small amounts of highly diluted solutions produced conjunctival and corneal edema and iris hyperemia. When administered intraperitoneally in the usual therapeutic dosages these drugs produced suture cataracts. Conjunctival instillation did not provoke cataracts nor edema of the conjunctiva or cornea. Neither previous nor subsequent instillation influenced the development of the cataract produced by intraperitoneal administration. If repeated, intraperitoneal administration may aggravate the previously induced damage. But even without further application, the cataracts show a tendency to progression. The authors stress the possibility of damage to the human lens by administration of these drugs and quote Ross (Am. J. Ophth. **7**:987, 1949) for similar observations on human eyes.

K. W. Ascher.

Bottino, Carlo. **Influence of illumination and of the diurnal cycle on the serum cholinesterase in man.** Ann. di ottal. e clin. ocul. **77**:174-179, April, 1951.

Bottino found that the cholinesterase activity is usually greater in the night hours or after prolonged darkness. This suggests a reason why attacks of acute glaucoma have a nocturnal onset and may help to explain the seasonal rhythm of vernal catarrh. Harry K. Messenger.

Cucco, Giovanni. **Histamine and the permeability of the blood-eye barrier.** Ann. di ottal. e clin. ocul. **77**:118-126, March, 1951.

The presence of fluorescein, previously injected intravenously, can be detected in the anterior chamber by the color it imparts to the aqueous. Amsler devised a method of measuring with the slitlamp its concentration in the aqueous and thus has provided a means of studying the permeability of the blood-aqueous barrier. Using this method Cucco studied the behavior of the barrier in rabbits after the administration of histamine subcutaneously, retrobulbarly, intravenously, and by instillation in the subconjunctival sac. The effect of the histamine, whatever the route of administration, was very evident; the permeability of the barrier was markedly increased in each instance. Particularly noticeable was the rapid response following instillation into the conjunctival sac; the conjunctival route was practically as effective as the intravenous. (6 graphs, references)

Harry K. Messenger.

Desvignes, P., and Roucayrol, J. C. **Can one determine the composition of the**

transparent media of the eye "in situ"? Arch. d'opht. 11:160-161, 1951.

The authors discuss the theoretical aspects of spectroscopy as related to examination of the aqueous, the lens, and the vitreous, and analyze the various methods that have been proposed, including absorption spectroscopy and emission spectroscopy. They conclude that in the present state of knowledge no method is applicable to the living eye.

Philips Thygeson.

D'Ermo, F. **Antihistamine drugs and the eye. VI. Synthetic antihistamines in allergic eye diseases.** Boll. d'ocul. 30: 135-160, March, 1951.

This extensive review contains, among other valuable details, a rather complete table of the antihistamine drugs synthetisized since 1942, their chemical constitution, dosage, name of the producer and of synonyms, an abstract of experiences with these drugs reported by previous investigators, and tables describing the results obtained by the author. Three-hundred-and-sixteen patients who suffered from various, possibly allergic, conditions are tabulated as to diagnosis, result of treatment, drug administered, type of administration, and gravity of condition. Administration was usually oral or by instillation into the conjunctival sac, rarely intravenous, more often intramuscular and very often combined. Phenergan and pyribenzamine were the chief drugs used. Other tables show the histamine content of the blood before and after treatment and the occurrence of eosinophilia in the blood, according to Code's method. Typically allergic lesions, such as Quincke's edema of the lids, and blepharoconjunctivitis due to contact, were rapidy improved by antihistamine treatment. The blood histamine content often became normal and the marked eosinophilia disappeared. Inconstant results were found in chronic conjunctivitis, blepharitis squamosa or ulcerosa, lymphatic keratitis, recurrent episcleritis, recurrent hypopyon iritis, uveitis phacoanaphylactic endophthalmitis, and glaucoma in allergic subjects. Antihistamine therapy is recommended as a tentative adjuvant and for subjective relief of symptoms. In 20 percent of the patients who were given systemic medication, insomnia or gastrointestinal complications occurred. (References)

K. W. Ascher.

D'Ermo, F., and Santirocco, N. **Antihistamine drugs and the eye. V. The effect of synthetic antihistamines on corneal sensitivity, intraocular pressure, pupillary diameter, and accommodation of the normal eye.** Boll. d'ocul. 30:99-111, Feb., 1951.

Antergan, neo-antergan, pyribenzamin, antistine, fargan, benadryl, para-aminobenzoic acid, and privin showed some anesthetic action on normal corneas, most definitely in antergan experiments where even the one-fourth per mille solution reduced the corneal reflex. This effect lasted sometimes longer than that of a one-percent cocaine instillation. Many of these drugs are harmful to the corneal epithelium. Conjunctival instillation of a 2.5-percent antistin solution reduced intraocular pressure of normal eyes 5 to 7 mm. Hg for a period of 30 to 40 minutes. The other drugs produced only a slight drop in intraocular pressure. Intramuscular application of these drugs was not followed by any change in intraocular pressure. It did not influence pupillary diameter and accommodation, but instillation of antergan (one per mille) produced slight miosis; para-aminobenzoic acid instillation, 20 to 30 percent, changed neither pupils nor accommodation while 1.5-percent benadryl instillation was followed by occasional mydriasis. (7 graphs, references)

K. W. Ascher.

Ferrata, Luigi. **The action of vasoconstrictors in angioscotometry.** Ann. di ottal. e clin. ocul. 77:115-117, March, 1951.

Dubois Poulsen found that acetylcholine injected intramuscularly caused considerable diminution in size of the angioscotoma, whereas Ferrata has found that the same substance injected retrobulbarly produces enlargement of the scotoma. His studies indicate the importance of the route of administration in evaluating the pharmacodynamic action of a drug, and show that, at least in the case of epinephrine, the angioscotoma responds normally when the drug is injected retrobulbarly.

Harry K. Messenger.

De Grósz, E., and Kedvessy, G. **The standardization of pilocarpine solutions.** Arch. d'opht. 11:155-159, 1951.

The authors discuss the pharmacology of pilocarpine, and particularly of its hydrochloride, and note the physiological inactivity of the acid which forms slowly in aqueous solutions. Pilocarpine also slowly transforms itself into pilocarpedine and into jaborine. A pH of 7 is best tolerated by the conjunctiva and over a 30-day period no drop in the effectiveness of pilocarpine in concentrations of 1 percent or greater could be noted. The following method of preparation is recommended: dissolve the pilocarpine salt in a solution containing 94 cc. of a boric acid solution (0.2 mol. or 1.2368 gm. in 100 cc. H_2O), 6 cc. of a solution of borax (0.05 mol. or 1.907 gm. in 100 cc. H_2O), and 0.22 gm. of sodium chloride. Zephiran 1:20,000 is used to protect the preparation from bacterial contamination. Phillips Thygeson.

Janny, P., and Cochet, P. **Does the pressure of the central retinal artery reflect the intracranial pressure?** Ann. d'ocul. 184:321-341, April, 1951.

Changes of intracranial pressure modify the pressure in the central retinal artery. Pressure changes in the central retinal artery, however, do not materially affect intracranial tension. Intracranial pressure was measured with an instrument consisting essentially of an elastic membrane, piston and magnetic circuit. Retinal tension was measured with a Bailliart ophthalmodynamometer, and variations in intracranial pressure were obtained by several methods, including the intraventricular injection of normal isotonic serum. Observations were made of the modification of the retinal arterial tension by artificially produced changes of intracranial pressure and pathologic intracranial hypertension in injuries and diseases. The technical problems involved are discussed in detail. Chas. A. Bahn.

von Studnitz, G. **Vision and visual substances.** Klin. Monatsbl. f. Augenh. 118: 1-15, 1951.

This article is the first part of a review on the more recent ideas on the biochemistry of visual purple, retinin, vitamin A, lutein, and helenien (an ester of the latter with dipalmitinic acid). Carotenoids play an important part in building up the visual purple of vertebrates. Lutein and helenien are of equal importance with vitamin A and its aldehyde, retinine, in this process, but it has not yet been determined how the various carotenoids function in this synthesis. Certainly helenien takes part in dark adaptation. The chemical basis of adaptation is a reversible process of destruction of the substance involved through the reassembly of the component parts in total darkness, supplemented by the addition of a new photochemical substance or its component parts for greater effect. Theodore M. Shapira.

4

PHYSIOLOGIC OPTICS, REFRACTION, COLOR VISION

Bonavolontà, G., and Sbordone, G. **Experimental observations on the variations in the ocular refraction following dia-**

thermocoagulation of the sclera. Ann. di ottal. e clin. ocul. 77:145-155, April, 1951.

The authors studied retinoscopically the refractive changes induced in the eyes of rabbits by various methods of application of scleral diathermocoagulation (Weve's technique for treatment of retinal detachment). The changes varied according to the method of application but were all characterized by variations in the astigmatism and in particular by a reduction in the total refractive power of the eye. These changes appear to be due to cicatricial contraction of the sclera, which causes modifications in the curvature of the cornea and a shortening of the anteroposterior axis of the globe.

Harry K. Messenger.

Bottino, Carlo. **Variations in the reading distance of corrected and uncorrected myopes.** Ann. di ottal. e clin. ocul. 77: 162-173, April, 1951.

Bottino made a series of measurements on the reading distance preferred by myopes under varying conditions, with and without mydriasis, and measured their refraction retinoscopically and then subjectively by Scheiner's method. High myopes, accustomed to interpreting blurred images, tend to hold print beyond their far point, thereby taking advantage of the greater depth of field. The slight loss in clarity of the image is outweighed by the lessening of the convergence effort.

Harry K. Messenger.

Brückner, R. **Vertical asymmetry of the isopters.** Ophthalmologica 121:12-25, Jan., 1951.

In patients with various functional diseases and on a few normal controls the author made the observation that the isopters for targets of small size and low relative brightness differed from the typical, approximately elliptic shape in that the portion above the horizontal meridian was considerably smaller than the portion below the horizontal meridian. All measurements were made on Goldmann's projection perimeter. Peter C. Kronfeld.

Kozlowski, Bogmil. **Glaucoma as late complication of lens extraction in high myopia.** Klinika Oczna 19:429-438, 1949.

A mother and daughter had lens extraction done to avoid wearing heavy glasses. Both had secondary glaucoma a few years after the operation, which required surgical intervention and evenually led to considerable loss of vision and of visual field. The daughter had macular changes and retinal detachment in one eye.

Sylvan Brandon.

Papagno, M. **Examination of the relaxation of accommodation useful for correction of ametropias.** Boll. d'ocul. 30:112-122, Feb., 1951.

After monocular acceptance tests and attempts to increase the plus lens binocularly, Papagno investigated the monocular and binocular acceptance at 2.50 meters. The results differ according to age, occupation, and astigmatic correction. Persons close to the age of 40, those without need for close vision, and those wearing full correction of an astigmatic error are believed to have a greater tendency for permanent relaxation of their accommodation and therefore can wear stronger plus (or lower minus) lenses than younger people or than persons who must do close work or who, for some reason, cannot wear the full astigmatic correction.

K. W. Ascher.

Renard, G., and Massonnet-Naux. **The pupillary-convergence synergy.** Arch. d'opht. 11:137-145, 1951.

The authors note the still existing confusion in regard to the relationship of the pupillary reaction to accommodation and convergence. They describe in detail the contraction of the iris to diverse stimuli and state that iris contraction in near vision begins when the object approaches 40 cm. and that the contraction is maxi-

mal when the object reaches about 10 cm. They note particularly that pupillary contraction increases parallel to the degree of convergence. Individual variations are common, however, and the reaction is influenced by the refractive state and by age.

In a physiopathologic study of normal subjects and of subjects with various abnormalities, including blindness, aphakia, Adie's syndrome, paralysis of convergence, and paralysis of accommodation, the authors conclude that the pupillary reaction is unrelated to accommodation but related exclusively to convergence. They propose the term "synergie pupillaire à la convergence" for the near vision reaction and consider the disappearance of this pupillary synergy as one of the major signs of paralysis of convergence.

Phillips Thygeson.

Segal, J. **The elements of a color vision theory.** Ann. d'ocul. **184**:214-245, March, 289-320, April, 1951.

Light waves are transformed into perceived colors primarily at three retinal levels which correspond with their wave lengths. The essentials involved are photosensitive chemicals, receptor cells and a transmitting mechanism. Each must be adapted not only to specific wave lengths but also to variable light intensities such as occur in day and night vision. Visible light waves range from the short wave violets (400-470 mμ), the intermediate blues, (450-500 mμ) and the greens, (530-660 mμ), to the long wave reds, (630-800 mμ). Incident light waves after passing through the cornea and other transparent media penetrate the retina. Upon reaching the external reticular layer (Henle fibers) all light waves come in contact with a carotenoid substance, transitory orange. Here the short wave lengths, (400-470 mμ), are transformed into the violet-purple type of neuro-chemical energy, both rods and cones acting as receptors. As the remaining light waves continue posteriorly, the intermediate blues and then the greens are transformed into visual stimuli. The longer-wave greens (530-660 mμ), are photosensitized only by cones and by visual purple, rhodopsin. All light waves have now been transformed into visual stimuli except the long-wave yellow-orange-reds (630-800 mμ), which are photosensitized at the level of the pigment epithelium by a group of carotenoid chemicals in microsuspension, both rods and cones acting as receptors.

The barriers against excessive light are visual orange for shorter waves (violets) and the pigment epithelium for longer waves (reds). The photosensitizing chemicals for all colors are carotenoid substances primarily formed by the pigment epithelium as a microsuspension whose exact chemical composition is unknown and which photosensitizes the long wave lengths (reds). At the level of cones where the intermediate wave lengths are photosensitized, this microsuspension is synethesized into visual purple (rhodopsin) by the catalytic action of light and a reversible enzyme mechanism. At the level of Henle fibers where the short wave violets are photosensitized, visual purple is reduced to transitory orange which may be re-synthesized into visual purple. How these several chemical groups maintain their relative retinal levels is not yet understood.

The color impulses previously described pass through the same optic nerve fibers which transmit three dimensional white-black impulses. In the external geniculate body a reorientation and coordination of three dimensional sight, including location and color vision, takes place. This is accomplished by the different rates of speed of the stimuli for different colors (chronaxia). Stimuli from the foveal mechanism (primarily cones) which dominate photopic or day-light vision are

arranged centrally and the impulses from the extrafoveal mechanism (rod, scotopic, night vision) are arranged more peripherally. Stimuli from shorter wave impulses are placed more anteriorly and those from longer wave impulses more posteriorly. This arrangement corresponds roughly with that in the retina and in the primary occipital visual centers. In the retinal relay the fibers which transmit foveal impulses carry only those of a single receptor cell. Fibers carrying extramacular impulses transmit the impulses from multiple receptor cells (principally rods). The transmission is accomplished by the inter-retinal fibers. As light changes from day to night, central visual acuity both for form and color becomes less distinct as the foveal-photopic mechanism becomes less dominant. Reds appear darker and blues lighter. If this transition is very rapid, after images may be seen in the foveal region, a transient red and then yellow often with a blue border. This phenomena (Purkinje) is caused by the incomplete transition from macular to extramacular vision. The carotenoid substances in the macular pigment epithelium retain the stimuli of red-yellows longest. The blue border is caused by the relative insensitiveness of the fovea to blues which are therefore visible at the extrafoveal margin. Those interested should study the original monograph which presents a most complete, understandable and logical presentation of this complex subject.

Chas. A. Bahn.

5
DIAGNOSIS AND THERAPY

Arató, Stephen. **A new motor-driven trephine for keratoplasty.** Ophthalmologica **121**:38-40, Jan., 1951.

The description of the instrument is not detailed enough to permit recognition of any radical deviations from or improvements over existing motor-driven corneal trephines.

Peter C. Kronfeld.

Comber, W. **Lid sutures in serious conditions of the eyeball.** Klin. Monatsbl. f. Augenh. **118**:81-83, 1951.

At the center of each lid, a suture is introduced through the lid margin. Each suture is tied, and one end left long. These long ends can be knotted in a regular knot or in a bow. It is not necessary to untie this knot, as the globe can be inspected by separating the lids on each side of the sutures. Medication can be instilled without untying the knot. The pain caused by the pull discourages the patient to open the lids. This type of suture may even eliminate the necessity for conjunctival sutures in cataract surgery. (3 figures)

Theodore M. Shapira.

Gamble, R. C. **Management of ophthalmologic problems in children.** Postgrad. Med. **10**:65-67, July, 1951.

The management of foreign bodies, lacerations of the eyelid, perforating injuries, styes, blepharitis, iritis, sympathetic ophthalmia, glaucoma, and retrolental fibroplasia are discussed from the viewpoint of the general practitioner.

Irwin E. Gaynon.

Geisel, Hans. **A simple aid for threading needles.** Klin. Monatsbl. f. Augenh. **118**: 81, 1951.

A fine wire loop, attached to a handle, is pushed through the eye of the surgical needle. After the suture material has been threaded through the wire loop, the latter is drawn back through the eye of the needle together with the suture. (1 figure)

Theodore M. Shapira.

Hartman, Edward. **Forceps for corneo-corneal and sclero-corneal sutures.** Ann. d'ocul. **184**:433-435, May, 1951.

The author's forceps combines the advantages of the St. Martin and Kirby forceps. The teeth, which are not too

large, are obliquely set in the blades which form an angle of about 15° and require only very light pressure. The forceps is small enough to comfortably fit the fingers. Chas. A. Bahn.

Hartman, Edward. **What the ophthalmologist should know about protheses.** Ann. d'ocul. **184**:342-345, April, 1951.

Plastic protheses are more practical because they are nonbreakable, and better tolerated by the conjunctiva and are lighter in weight. Protheses should be inserted 10 or 12 days after enucleation or evisceration irrespective of orbital or lid edema. The orbital and conjunctival tissues are thus moulded for the greatest motility and most sightly appearance. Large protheses stretch the tissues more, but are less comfortable because they increase the lid opening and reduce motility. The three dimentional size of the lid opening may apparently be increased with +4.00 to +6.00 spherical and appropriate cylindrical lenses. Double wall protheses are preferably removed every night, and the use of a slight lubricant is suggested. The socket is best cleansed with a 0.75-percent sodium chloride solution but frequent irrigation is undesirable. If there is an associated conjunctivitis, the protheses should preferably not be removed, and should not be left out for more than five days because of the retraction of the orbital tissue. Chas. A. Bahn.

Horne, G. O. **Topical cortisone in treatment of syphilitic ocular disease.** Brit. M. J. **1**:1289-1291, June 9, 1951.

Cortisone has been found to be beneficial in reducing the pain and photophobia present in interstitial keratitis even in doses as small as one drop of a solution containing 5 mg. per cc. of normal saline solution, instilled every three hours. A rapid improvement in vision was brought about. The treatment of the syphilis with penicillin, arsenic, bismuth and fever therapy should be continued as long as is necessary, regardless of the relief given the patient by the local use of cortisone. Cortisone is not curative but appears to inhibit the inflammatory and exudative reactions typical of a hypersensitivity, and relapses may be expected on withdrawal of the hormone as long as a hypersensitive state exists. Five cases are reported.

Herman C. Weinberg.

Johnson, E. A. **Intravenous morphine in ocular surgery.** Canad. M.A.J. **64**:429-433, May, 1951.

One hundred and one patients, whose eyes were to be operated upon, were given sodium amytal at night and three grains of sodium amytal in the morning, two hours before operation. This was followed by local anesthesia and the intravenous injection of a solution of which 4 cc. contains ¼ grain morphine sulphate, ⅙ grain ephedrine sulphate, 1/200 grain scopolamine hydrobromide, and 2 cc. of ½ percent of chlorobutanol. In all patients over the age of 75 years, and thin patients over the age of 65, 2 cc. of this solution was injected at the rate of 1 cc. in two minutes; 3 cc. was used for patients between the age of 55 and 70 and 4 cc. for younger patients. Psychic sedation was obtained in 10 minutes and maximum analgesic action in 20. Tachycardia occurred in 25 percent and respiratory depression with slight cyanosis in 3 percent. No cases of morphine sensitivity were seen. Postoperative headache was found in 6, mild nausea in 10, vomiting in 4, and mild excitement in 3 patients. The patients who had been given morphine were much quieter and more cooperative than other patients.

Herman C. Weinberg.

Klinowski, Czeslaw. **Iontophoresis in treatment of eye diseases.** Klinika Oczna **19**:383-412, 1949.

The author discusses in detail the physical and technical aspect of iontophoresis as applicable in the ophthalmologist's practice and describes the indications and the technique of application for most of the drugs used in ophthalmology. He reports 70 cases of iritis, 9 of glaucoma and 12 of corneal ulcer, all treated by iontophoresis. In 11 cases treatment was delayed and not effective; in three cases of acute glaucoma, calcium and adrenalin iontophoresis lowered tension but in chronic glaucoma only two out of four responded with temporary lowering of tension. In two other cases of glaucoma and in two cases of secondary glaucoma pilocarpine iontophoresis gave good results. Zinc sulphate iontophoresis accelerated healing of corneal ulcers; however, sulfonamides and milk parenterally were used at the same time.

Sylvan Brandon.

Lavery, F. S., Werner, L. E., O'Donoghue, D., Guinan, P. M., and Macdougald, J. **Use of cortisone in diseases of the eye.** Brit. M. J. 1:1285-1289, June 9, 1951.

One hundred and forty three diseases of the eye including keratitis, iritis, sympathetic ophthalmia, scleritis, choroiditis and post-operative iridocyclitis were treated with local instillation and subconjunctival injections of cortisone. Six cases are discussed in detail. There was marked improvement in 27, moderate in 22, and none in 34. Subconjunctival injection of cortisone immediately after cataract extraction performed on six patients, was thought to be useful in preventing post-operative reactions from intraocular surgery. Cortisone is valuable in the control of allergic reactions in the eye, but has no affect on the underlying disease.

Herman C. Weinberg.

Much, Viktor. **Lemon juice in the treatment of indelible pencil injuries of the eye.** Ophthalmologica 121:43, Jan., 1951.

Conjunctival burns due to fragments of indelible pencil lead respond favorably to repeated irrigations with fresh lemon juice.

Peter C. Kronfeld.

Much, Viktor. **Promotion of the absorption of lens material by ultra-short wave therapy.** Ophthalmologica 121:41-43, Jan., 1951.

In several cases of extracapsular cataract extraction and slow absorption of the retained lens material, ultra-short wave therapy seemed to accelerate the process of breakdown of the lens cortex.

Peter C. Kronfeld.

Roberts, W. E. **Roentgenographic demonstration of glass fragments in the eye.** Am. J. Roent. 66:44-51, June, 1951.

Exposure for demonstrating glass fragments in the eye or orbital tissue should be made at varying angles and penetrations. Most bifocal lenses are more radio-opaque than the distance lens and persons employed in hazardous occupations should wear a lens of the most marked radio-opacity.

Irwin E. Caynon.

Smith, Ferris. **Flaps utilized in facial and cervical reconstruction.** Plast. and Reconstr. Surg. 7:415-455, May, 1951.

Part of this collective review considers eyelid reconstruction. In large facial reconstructions, ectropion of the lid should be repaired as the last stage of the procedure after anchorage of the other advanced skin has been completed. The author favors the plan of intermarginal lid adhesions with a free skin graft when indicated. In other cases he uses sliding flaps, or tube pedicles. The postoperative result of the Machek-Gifford operation for unilateral or bilateral ptosis is shown, but a differentiation of surgical approach for the correction of ptosis in relation to the retained functions of the levator or superior rectus muscles is not presented. The author's drawings from his text, Plastic

and Reconstructive Surgery, of an island flap for reconstruction of a lower lid are included. There are photographs of 35 cases, each with a series of four to six photographs of various reconstructive stages; eight of these deal with lid problems. Alston Callahan.

Trope, R. A. **Cortisone in eye disease, three case reports.** South African M. J. 25:349-350, May 26, 1951.

In three cases, one of dendritic ulcer with secondary glaucoma, one of aphakia with iridocyclitis, and one an ulcerated lime burn of the cornea, cortisone was used effectively after previous failure with routine and anti-biotic therapy.

Irwin E. Gaynon.

Trovati, Emma. **Visual disturbances and transitory changes in the fundus after roentgenotherapy on the cranium in children affected with tinea: clinical note.** Ann. di ottal. e clin. ocul. 77:127-131, March, 1951.

Nineteen children suffering from ringworm of the scalp underwent X-ray treatment sufficient to cause complete loss of hair. All but four complained of blurred vision after the second application, and in some cases a marked dilatation of the retinal vessels was observed, particularly after the third application. In no case were the changes permanent. The blurring of vision can perhaps be ascribed to retinal edema too slight to be detected ophthalmoscopically. Radiologists, however, should bear in mind the possibility of damage to vision.

Harry K. Messenger.

6

OCULAR MOTILITY

Arkin, Wiktor. **The visual field in squint.** Klinika Oczna 19:317-332, 1949.

There is no agreement as to the frequency, size and localization of scotoma in squint. It may be due to special difficulties in establishing the visual axis of the squinting eye, and inhibitions appearing when the other eye is open. There is a basic difference between the area of inhibition and the area of scotoma. Determination of the visual field in squint may be monocular, binocular, and separately binocular as in a stereocampimeter of Lloyd. The squinting eye should be thoroughly tested and retinal correspondence determined. Visual fields are tested on a perimeter or campimeter and a binocular field is measured by placing differently colored glass in front of each eye and using the proper targets. For binocular but separate fields the author uses Pigeot-Cantonnet's stereoscope. He could not find scotoma when visual acuity was better than 5/50. Visual scotoma was found only in cases of marked amblyopia and was located in the center of the visual field. The eye could not fix and the scotoma was in a place that corresponded to the macula of the fixing eye but did not include the macula of the squinting eye.

There are three types of binocular fields. 1. The visual field is dominated by the fixing eye. There is only inhibition of the area corresponding to the macula of the squinting eye. 2. This covers the majority of squints. The visual field is similar to the first type but the temporal periphery of the field on the side of the squinting eye is seen in the color of that eye. 3. There is double vision in a part of the field. This type exists only in experimental conditions. The analogy between this type of vision and the dominance of one eye in the binocular visual field is discussed. Sylvan Brandon.

Hartleib, R. **A simplified apparatus for orthoptic exercises and the measurement of strabismus.** Klin. Monatsbl. f. Augenh. 118:15-21, 1951.

A simple haploscope is described in which the targets are viewed in mirrors

which are fixed at an angle of 90 degrees. If these fixed mirrors are moved towards the patient, the targets seem to separate, allowing fusion in case of convergent strabismus. As the pair of mirrors is moved away from the observer, the targets seem to move towards each other and, eventually, cross, a position suitable in divergent strabismus. A series of pictures is supplied with the haploscope which are larger than usual and printed in four colors. The equipment is suitable for orthoptic exercise of patients with convergent or divergent strabismus at any interpupillary distance. (2 figures)

Theodore M. Shapira.

Hentschel, F. **Treatment of strabismus.** Klin. Monatsbl. f Augenh. **118**:23-33, 1951.

A general outline of conservative and surgical treatment of strabismus is given that does not add any new facts to the Anglo-American concept of the subject. Early examination and treatment are stressed. Strabismus is a psychosomatic disease and operation must be followed by training in fusion. Two cases of "horror fusion" are reported.

Theodore M. Shapira.

Malbran, Jorge. **Causes of failure in the treatment of strabismus.** Arch. d'opht. **11**: 5-11, 1951.

The author analyzes causes of failure in the management of strabismus under three headings: 1. incorrect etiopathologic diagnosis, 2. delayed treatment, and 3. inappropriate technique. Under the first heading he stresses the need for an analysis of the cause, whether accommodative or paralytic, or due to anomalous position induced by congenital abnormalities, and points out the need for an analysis of the vertical factors so common in strabismus. Under the second heading he deplores the conditions, in large part preventable, which lead to delay in treatment and consequently to suppression, amblyopia, and anomalous retinal correspondence. He notes the poor prognosis in anomalous correspondence and the somewhat better prognosis in cases which have both normal and abnormal correspondence, and stresses the value of treatment by occlusion, together with orthoptics and surgery. Under the third heading he discusses the role of the choice of technique in the results and the importance of making the right choice and of the timing of the procedure. As an example he notes the unfavorable effect of the use of the cheiroscope in cases of anomalous correspondence and its favorable effect in cases with normal correspondence. He discusses in detail the various surgical techniques with their indications and contra-indications and he favors the age of four for most surgery since pre- and post-surgical orthoptic training is possible at this age. Phillips Thygeson.

7

CONJUNCTIVA, CORNEA, SCLERA

Descamps, J. **The etiology and treatment of pterygium.** Ann. d'ocul. **184**:436-451, May, 1951.

In the eye clinics of central Asia, one of every three patients has actual or potential pterygium. This frequency is due to environment, time and constitution. The long exposure to heat, dryness, wind, dust, inverted lashes and other slight irritants is often associated with subconjunctival degenerative products such as occur in pingueculae. There is a potentially lowered limbal barrier to corneal invasion by conjunctival and subconjunctival hyperplasia and neovascularization because Bowman's membrane does not quite extend to the limbus. When there is a defective barrier, modified enzyme function, and long exposure to external subconjunctival irritants slight limbal edema, with such changes as

altered pH, will ensue. These conditions invite conjunctival and subconjunctival hyperplasia and corneal invasion, usually with neovascularization, which is always in the same direction as the pre-existing vessels.

In pterygium operations, the entire growth on the cornea and the involved episcleral and subconjunctival tissue should be removed and the pterygium pattern should be changed so that corneal re-epithelization toward the limbus will be more rapid than pterygium regrowth inward. The surgical procedures are described. Chas. A. Bahn.

Hermann, Pierre. **The keratitis of mycosis fungoides.** Arch. d'ophth. **11**:39-45, 1951.

The author stresses the rarity of the ocular complications of mycosis fungoides and notes the fact that no histologic study has been made of affected ocular tissues. He reports the case of a patient with an interstitial keratitis which preceded by several years the development of mycosis fungoides and which was of such severity that it necessitated keratoplasty. Histologic examination of the excised button of corneal tissue showed a pathologic picture comparable to that of the skin disease and the author concludes that the corneal complications of the disease can antedate by varying times the onset of the cutaneous lesions. He reviews in detail the pertinent data concerning the disease, its diagnosis and clinical course as well as its unsatisfactory therapy. Two illustrations, one from a biopsy of the skin and the other from the corneal button, are presented to point out the histologic characteristics.

Phillips Thygeson.

Panzardi, D., and Pasca, G. **Bacteriologic and clinical investigations on the action of bacitracin and of streptomycin alone and combined with penicillin, on the conjunctival flora.** Boll. d'ocul. **30**: 179-188, March, 1951.

The authors employed solutions and ointments of bacitracin prepared by the Casa Tubi Lux in Naples, to study the bacteriologic response of 60 patients whom they tested by smear and culture before and after application of the drug. In one group of 20, a solution containing 1,000 units per cc. was instilled every four hours. The solution had been freshly made up and the antibiotic activity of the original solution was repeatedly tested by in vitro experiments. A second group of 20 received a bacitracin ointment (250 units per gram) four times a day into the right eye and streptomycin ointment (5,000 units per gram) into the left. The third group of 20 patients received the bacitracin ointment in double strength into one eye and a combined streptomycin-penicillin ointment (2,500 units per gram of each substance) into the other eye, again four times a day. A table describes diagnosis, bacteriology, duration of treatment, time of disappearance of the bacteria, and tolerance. Bacitracin was well tolerated and caused disappearance of the conjunctival flora within two to four days. Drops and ointment produced sterility that usually lasted five to eight and at most 12 days after cessation of therapy. Ointment containing 500 units per cc. sometimes caused slight burning. Streptomycin sterilized the conjunctiva after 24 to 48 hours of administration and permitted the growth of saprophytes only 6 to 12 days after it was discontinued. It was very well tolerated. Combined streptomycin-penicillin ointment cleared the conjunctiva within 24 hours and no growth was observed for 12 to 15 days thereafter. No side effects were observed. Clinical improvement was parallel to the reduction of the flora. Best results were achieved with the combined ointment, even in trachoma cases. Good postoperative results were obtained in eyes pre-

operatively treated with this streptomycin-penicillin ointment. K. W. Ascher.

Yaeji Ito, and Chiang-Hua Yu. **Early signs of trachoma observed by the slitlamp.** Brit. J. Ophth. 35:304-305, May, 1951.

Slitlamp examination of 400 trachomatous eyes at various stages, 20 eyes with normal conjunctiva, and 58 with epizootic conjunctivitis showed the authors a new clinical sign of very early trachoma. The bulbar conjunctiva was examined by reflected light; an undulatory or rippled reflection accompanied by a bubbly effect was seen in the initial stage; a reflection of goose-skin appearance at the height of trachoma, and a smooth glossy reflection in the normal conjunctiva. These changes, seen chiefly in the upper quadrants, occurred in a very high percentage of cases, and were more frequent in early trachoma than when pannus formation was present.

Morris Kaplan.

8

UVEA, SYMPATHETIC DISEASE, AQUEOUS

Desvignes, Pierre. **Iridocyclitis, is it a tissue disease or a blood disease?** Arch. d'opht. 11:46-51, 1951.

The author poses the question as to whether iridocyclitis is a tissue disease in which the initial lesion is in the iris or ciliary body, with elimination of dead cells into the aqueous and vitreous, or whether the initial disease is humoral with secondary involvement of the tissues bathed by the aqueous humor. He concludes that the latter is the case and cites in support of his opinion certain clinical charactersitics of the disease, including the acute onset in connection with which the symptoms often precede the gross iris changes. In addition he cites the ease with which it is possible to incite an iridocyclitis by injecting toxic substances into the aqueous and refers to the studies of Amsler and Verrey who noted in anterior chamber punctates from acute iridocyclitis at onset only leukocytes of blood origin. Desvignes calls attention to the fact that in histologic specimens the reactions are always maximal in the iris angle and around the episcleral veins which drain the angle. He concludes with speculations on the therapeutic indications of his theory.

Phillips Thygeson.

Laws, H. W., and Howard, R. P. **Sympathetic ophthalmia treated successfully with ACTH.** Canad. M. A. J. 64:530-531, June, 1951.

Nineteen days after an injury to one eye, symptoms of sympathetic ophthalmia began to appear in the other eye. Treatment consisted in enucleation of the injured eye. 500 mgm. of ACTH were injected intramuscularly over a period of eight days. After 396 days there has been no recurrence of the ophthalmia. Vision is 20/20. Previous treatment with antibiotics and fever therapy had not been effective. Herman C. Weinberg.

Matteuci, P. **Pathologic considerations concerning the heterochromia of Fuchs.** Ann. d'ocul. 184:385-403, May, 1951.

The Fuchs type of iris heterochromia is essentially a very slowly progressive process of degeneration and inflammation. The chief symptom is tissue absorption and a constitutional predisposition, possibly of enzymatic origin may play an important part in its cause. The simple or sympathetic type of heterochromia, with which it is frequently confused, is self-limited and follows injury or disease of the cervical sympathetic on the same side. In the classical Fuchs type the gross structural abnormalities include a lighter color of the iris and diminished detail, semidilated and semireacting pupils, very slight aqueous relucence, with deposits

on the posterior corneal surface and the anterior lens capsule, and occasionally uveal fibroplastic replacement tissue. With transillumination or microscopically, stromal and posterior pigment absorption, usually without fibroplastic replacement, is seen; there may also be secondary, slight mononuclear infiltration. The frequently associated hyper- or hypotension depends on the uveal reaction. In the self-limited simple or sympathetic type, the pupil is contracted (Horner's syndrome), the progressive stage is of short duration, and evidence of sympathetic nerve impairment is present. Eleven illustrative cases are discussed in some detail. Chas. A. Bahn.

9

GLAUCOMA AND OCULAR TENSION

Bottino, Carlo. **Considerations on a case of a simultaneous attack of congestive glaucoma and acute deafness.** Ann. di ottal. e clin. ocul. 77:132-136, March, 1951.

Bottino reports the case of a 56-year-old man who lost his hearing at the time of an attack of acute glaucoma. He reviews the literature and concludes that the anatomic affinities between ear and eye justify the possibility that the same etiologic agent may affect both organs simultaneously. It is possible that some neurovegetative factor, the exact nature of which is at present unknown, may give rise to a humoral imbalance wherby the pressure of both the intraocular fluid and the endolymph is increased. (References)

Harry K. Messenger.

Čavka, V. **Non-perforating cyclodiathermy with cyclodialysis circumscripta in glaucoma.** Brit. J. Ophth. 35:307-312, May, 1951.

Nonperforating cyclodiathermy has been used successfully since 1936. The author had previously described the combination of this operation with iridodialysis but now prefers the combination with cyclodialysis circumscripta which he describes. A conjunctival flap is made from the 3 to the 9-o'clock position 5 mm. from the limbus, and a muscle hook is placed beneath the superior rectus for fixation. The diathermy is applied in both horizontal and vertical lines with a 1.5-mm. ball electrode; 50 milliamperes are used for one second. Cyclodialysis is then done with the sclerotomy at 12-o'clock, 2 mm. from the limbus with the sweep from 11:30 to 2:30-o'clock. Fifty-three eyes in 43 patients were operated on, 30 of primary and 13 of secondary glaucoma. In 41 eyes the pressure was made normal and in all it was reduced. In some the diminution was as much as 40 mm. Postoperative complications were negligible and in most cases vision also was improved. The technique described is equally satisfactory in primary, secondary and absolute glaucoma.

Morris Kaplan.

Rossetti, Dino. **Zosteriform eruption and ocular hypertension.** Ann. di ottal. e clin. ocul. 77:101-114, March, 1951.

A 12-year-old girl had had six attacks of acute ocular hypertension associated with recurrent zosteriform eruption in the trigeminal region of the face, at times accompanied by cyclitis and other manifestations of inflammation of the anterior segment. Clinical evidence favored a diagnosis of zosteriform herpes rather than of true herpes zoster. Biologic tests showed the virus to be neurotropic as well as dermotropic. Rossetti believes allergy may have been a basis for the repeated glaucomatous attacks, especially since the affected eye had a persistent pupillary membrane. Congenital anomalies have been regarded as predisposing to hypersensitivity and conducive, under certain conditions, to ocular hypertensive crises. (References)

Harry K. Messenger.

Smith, E. Temple. **A glaucoma problem.** M. J. Australia 1:193-194, Feb. 3, 1951.

A 65-year-old man developed glaucoma for which a Lagrange procedure was performed. Sixteen months later a perforation developed in the bleb which was followed by loss of the anterior chamber and cataract formation. The bleb was sealed, the cataract was extracted and an iridotomy was done. The final vision was 6/6. Irwin E. Gaynon.

10

CRYSTALLINE LENS

Hudson, J. R. **Intracapsular extraction by Kirby's technique.** Brit. J. Ophth. **35**: 284-290, May, 1951.

During an 11-month period, 60 intracapsular cataract extractions were done on selected cases by the Kirby technique.

The operative technique is described. In six cases the capsule was ruptured but vitreous was never lost. Most of the patients had vision of 6/12 or better. No reason could be found for reduced vision when it occurred. (4 figures)

Morris Kaplan.

11

RETINA AND VITREOUS

Bogdan, Andrew. **Microcephaly with chorioretinopathy, cerebral calcification and internal hydrocephalus.** Proc. Roy. Soc. Med. **44**:225-225, March, 1951.

A five-month-old infant had a large area of chorioretinopathy at the macula. X-ray examination of the skull showed cerebral calcification, internal hydrocephalus and cortical atrophy. The patient's mother reacted to the intradermal injection of $\frac{1}{500}$ toxoplasmin but a sister and the patient did not. (2 figures)

Herman C. Weinberg.

Bonnet, Paul. **The prethrombosis sign observed in retinal vessels in arterial hypertension; its semeiologic value.** Arch. d'opht. **11**:12-34, 1951.

In 1934 Bonnet and Paufique in an article on thrombosis of the central retinal vein described alterations in and around arteriovenous crossings consisting in hemorrhages, white halos around the veins, and exudates beneath the sites of crossing and suggested that they might be indications of future thrombosis. They considered these alterations indicators of defective venous circulation and called them 'the prethrombosis sign." Since then Bonnet has tested this hypothesis and cites eight case histories in which thrombosis followed the development of the sign. He noted, however, that considerable periods of time after the development of the sign could elapse before the thrombosis, although in his second case the thrombosis developed a month after the sign was discovered. The article is well illustrated with 20 drawings in black and white and the pathology of the arteriovenous crossing is described in detail.

Phillips Thygeson.

Cati, P. **Movable, nonparasitic cysts of the vitreous body.** Boll. d'ocul. **30**:161-178, March, 1951.

The cyst is described as a yellowish, round body with dark dots floating behind the lens, without visible attachment to it or to any other ocular structure. The eye had normal vision, transparent media and a normal fundus. The cyst was not always visible but could be brought into the axial area by tilting the patient's head forward. A table describes 18 previous cases as to location, size and shape, color, possible pigmentation, transparency, motility and pathogenesis of the cysts. Most of these bodies are spherical or ovoid; their color is yellowish, pink or gray, the majority show pigment dots and they are either semi-transparent or transparent. They are movable with a tendency to sink into the lower part of the vitreous,

and are about one or two disc diameters in size; the elliptical bodies have an apparent diameter of 5 by 3 mm. Embryonic mesoderm, uveal tissue, particularly of the ciliary body, or the primary vitreous have been assumed as the matrix. Cati favors the explanation brought forward by Lewy-Wolff (Klin. Monatsbl. 88:593, 1932), who assumed that these cysts derive from the anterior retinal layers and were originally pedunculate but later on lost their thin stalk. (4 figures, references) K. W. Ascher.

Gordon, D. M. **Routine examination of the ocular fundi as an aid in management of toxemias of pregnancy.** J.A.M.A. **146**:810-813, June 30, 1951.

The first sign of impending circulatory difficulty is narrowing of the retinal arteries. This is followed by localized spasms of the arterioles usually in the temporal portion and close to the disc. If the pregnancy is terminated at this stage, permanent vascular damage does not occur. When narrowed or spastic arteries begin to relax and return to normal fetal death is threatened and immediate interference must be considered.

At a still later stage vascular sclerosis ensues, if pregnancy has not been terminated. After retinopathy has developed the chance of a live baby is slight and permanent circulatory damage to the mother is certain. Irwin E. Gaynon.

Redslob, E. **Retrolental fibroplasia.** Ann. d'ocul. **184**:246-252, March, 1951.

In this interesting review especially of American literature, the author, who is one of Europe's foremost ophthalmic clinicians, asks pertinent questions concerning the unsolved problems of retrolental fibroplasia. This condition is inflammatory and occurs more frequently in prematures, but why is it not more frequent in prematurity due to uterine inflamation? Why is retrolental fibroplasia reported so much more frequently in American than in other ophthalmologic literature? Is its occurrence or observation more frequent in America? Are not the motley group of inflammatory-degenerative symptoms considered as retrolental fibroplasias by American authors named otherwise in other countries, infantile exudative peripheral retinitis (Coats's disease), infantile peripheral retinal angiomatosis, pre- and postnatal uveitis of varied etiology with secondary lenticular and retinal degeneration, pseudo glioma, for example?

Although the monocular form of retrolental fibroplasia is more frequent in full term births and the binocular form in prematures, what specific relation has prematurity to retrolental fibroplasia and in what cases?

Why do writers on this subject differ so widely concerning its etiology? Among the causes mentioned are: encephalo-ophthalmic dysplasia, primary vitreous persistence, maternal measles and other viral infections, light exposure, and hormonal imbalance. No surgical or other treatment at this time has changed the course of retrolental fibroplasia sufficiently to justify its use.

Chas. A. Bahn.

13

NEURO-OPHTHALMOLOGY

Dickman, G., Cramer, F., and Kaplan, A. **Opto-chiasmatic arachnoiditis; surgical treatment and results.** J. Neurosurg. **8**:355-359, July, 1951.

Of the 47 patients studied, postoperative results were considered unsuccessful in 63 percent. There was one death, improvement in 6, no change in 1, and aggravation in 12 cases. Immediate postoperative radiation therapy is of benefit and should be prescribed routinely. Surgery may be of benefit by liberating the optic nerves and chiasm after the exudative,

adhesive and membranous lesions have set in. (References) Bennett W. Muir.

Yuhl, E., and Rand, C. **Tuberculous opticochiasmatic arachnoiditis; report of a case.** J. Neurosurg. **8**:441-443, July, 1951.

A 25-year-old man rapidly developed marked cerebral symptoms and loss of fields 11 months after an acute illness and temporary improvement. At operation both optic nerves and chiasm were surrounded by dense, matted adhesions which were divided surgically. His general and ocular condition improved dramatically. Shortly thereafter, a destructive process was found in the 11th thoracic vertebra; a paraspinal abscess, which apparently had been missed previously, was also present. The paraspinal abscess was drained but did not heal. A few months later the patient died of tuberculous pulmonary complications. At autopsy, extensive, disseminated arachnoiditis was present over the entire brain stem and the base of the brain, caseo-cavernous tuberculosis was present in both lungs, and miliary nodules were found in the spleen and kidneys. The optic nerves and chiasm were free of adhesions. (3 figures, references)

Bennett W. Muir.

14

EYEBALL, ORBIT, SINUSES

Doggart, J. H. **Ocular manifestations in bone disease.** Ann. Roy. Coll. Surg. **8**:298-308, April, 1951.

Some of the topics covered are, hydrocephalus, oxycephaly, hypertelorism, Paget's disease, Crouzon's disease, endocrine displasia, and Boeck's sarcoidosis.

Irwin E. Gaynon.

Falconer, M., and Alexander, W. **Experiences with malignant exophthalmos.** Brit. J. Ophth. **35**:253-283, May, 1951.

The facts and theories concerning malignant exophthalmos are numerous and conflicting and there exists little agreement on etiology, pathology, physiology or treatment. This condition is not to be confused with the mild bulbar protrusion caused by a retraction of the upper lid in Graves' disease which is promptly relieved by treatment. It is, rather, an actual malignant protrusion of the eyeball, associated with ophthalmoplegia, and does not recede with treatment of any thyroid disturbance.

Mulvany distinguishes two types of exophthalmos, one thyrotoxic and the other thyrotropic, the former due to an excess of thyroxin, the latter to an excess of pituitary thyrotropin. The first should be treated by thyroidectomy or iodine, the second by the administration of thyroid substance and by decompression of the orbit. Twelve cases of malignant exophthalmos are reviewed which, the authors believe, show the above division of the disease into two groups to be basically faulty. They believe that the underlying condition is the same in all cases, with variations only in extent. Biopsy showed edema of the muscle tissue, with degeneration in the muscle fibers and lymphocytic infiltration. The disease is self-limited and improvement after treatment was probably coincidental. In 5 of the 12 patients thyroidectomy was performed and in 9 orbital decompression. There is probably some relationship between malignant exophthalmos and the thyroid and pituitary glands, but it must be an indirect relationship as the administration or the removal of hormones was without effect. Even orbital decompression failed to produce much benefit and there was a return of protrusion after an initial recession. (14 figures)

Morris Kaplan.

NEWS ITEMS

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News items should reach the editor by the 12th of the month but, to receive adequate publicity, notices of postgraduate courses, meetings, and so forth should be received at least three months before the date of occurrence.

ANNOUNCEMENTS

RESEARCH STUDY CLUB COURSE

The Research Study Club of Los Angeles announces its 21st annual midwinter postgraduate clinical convention in ophthalmology and otolaryngology, January 14th through 25th. The first week, January 14th through 19th, will be devoted to ear, nose, and throat. The second week, January 21st through 25th, will be devoted to the eye.

The guest speakers for the eye course will include Sir Stewart Duke-Elder of London, England, and Dr. Meyer Wiener of Coronado, California. In addition, the resident speakers for the eye will be Dr. Harold F. Whalman, Dr. S. Rodman Irvine, Dr. A. Ray Irvine, Jr., Dr. Clarence H. Albaugh, Dr. Warren A. Wilson, Dr. Carrol L. Weeks, and Dr. John A. Bullis.

Duke-Elder, director of the Research Institute of Ophthalmology, University of London, surgeon oculist to H.M., the king, consultant to the British Army and the Royal Air Force, Moorfields Hospital and St. George's Hospital, will cover the entire glaucoma problem, a subject in which he has been profoundly interested and has done much basic research.

Dr. Wiener, emeritus professor of clinical ophthalmology, Washington University School of Medicine, Saint Louis, will present his usual course in surgery of the eye. Because of the difficulty in handling a larger class for practical demonstration on animal eyes, this special course by Dr. Wiener and associates will be limited to 24 students. Applications will be accepted in the order in which they are received. This course will start Friday afternoon, January 18th, and continue Saturday afternoon and all day Sunday. It will consist of a short explanation of the procedure to be followed, with demonstration on animal eyes by the instructors, after which the student himself will perform under supervision. A list of required instruments will be mailed to applicants.

COLLEGE OF SURGEONS PROGRAM

At the San Francisco Clinical Congress of the American College of Surgeons, the following program will be presented for the Ophthalmology Section. On Tuesday and Thursday afternoons, November 6th and 8th, color television of ophthalmic operations will be shown.

At the evening sessions, Tuesday, Wednesday, and Thursday, November 6th, 7th, and 8th, the following papers will be presented.

November 6th: Symposium on "Injuries of the eyes and adnexa": "Contusions," Dr. Michael J. Hogan, San Francisco; "Lacerations of eye and adnexa," Dr. Harold G. Scheie, Philadelphia; "Chemical burns of the eye," Dr. Ralph S. McLaughlin, Charleston, West Virginia; "Thermal burns," Dr. Brendan D. Leahey, Lowell, Massachusetts; "Secondary repair of fractures," Dr. John Marquis Converse, New York; "Secondary repairs of chemical and thermal burns," Dr. Edmund B. Spaeth, Philadelphia.

November 7th: Symposium on "Cortisone and ACTH in ophthalmology": "Cortisone in ophthalmology," Dr. S. Rodman Irvine, Beverly Hills, California; "Local use of ACTH and cortisone in ulcers," Dr. Phillips Thygeson, San Jose, California; "Local use of ACTH and cortisone in burns," Dr. Irving H. Leopold, Philadelphia; Discussion, Dr. Moacyr Eyck Alvaro, Sao Paulo, Brazil.

November 8th: "Experiences with tumors of the retina," Dr. Kenneth C. Swan, Portland, Oregon; "Technical points in the surgery of retinal detachment," Dr. Dohrmann K. Pischel, San Francisco; "Late vitreous complications following intracapsular cataract extraction," Dr. David O. Harrington, San Francisco; "Present status of goniotomy," Dr. Otto Barkan, San Francisco.

NEW ORLEANS MEETING

The New Orleans Academy of Ophthalmology was recently organized and the following officers elected: Dr. James H. Allen, president; Dr. Charles A. Bahn, vice president; Dr. George M. Haik, secretary; and Dr. William B. Clark, treasurer.

The first midwinter convention and conference of the New Orleans Academy will be held January 2, 3, and the morning of January 4, 1952, and will feature a conference on glaucoma. Among the honor guests will be Sir Stewart Duke-Elder of London and Dr. Paul Chandler of Boston. Reservations for the meeting and hotel reservations may be obtained by writing any one of the officers or Dr. Jonas Rosenthal, National Bank of Commerce Building, New Orleans, Louisiana. Registration fee for the meeting will be $50.00, which includes associate membership in the New Orleans Academy of Ophthalmology.

PERSONALS

Dr. Rocko M. Fasanella has been appointed assistant clinical professor and head of the Department of Ophthalmology at the Yale University School of Medicine. Dr. Eugene M. Blake is now professor emeritus.

PRESCRIPTION OPTICIANS

Ophthalmologica

International Journal of Ophthalmology
Journal international d'Ophtalmologie
Intern. Zeitschrift für Augenheilkunde

Organ der Schweizerischen Ophthalmologischen Gesellschaft - Organe de la Société Suisse d'Ophtalmologie. Organ van het Nederl. Oogheelkundig Gezelschap - Organ for the Netherl. Ophthalm. Society

It is the task of "Ophthalmologica" to advance our knowledge in Ophthalmology by stimulating international co-operation. We publish:

1. Papers in English, German and French.
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3. Notes on practical questions. These columns are to be devoted to short interesting observations on cases occurring in everyday practice. They will appear in concise form, perhaps accompanied by an illustration.
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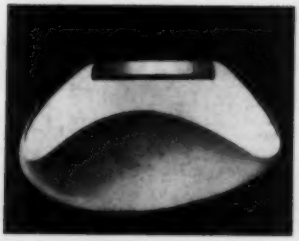

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